

**NEW SERIES**

**SELECTED  
WATER  
RESOURCES  
ABSTRACTS**



**VOLUME 2, NUMBER 8  
APRIL 15, 1969**

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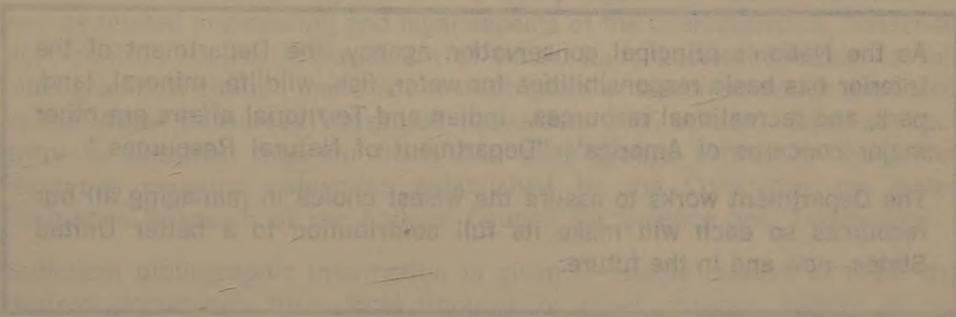


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U.S. Department of Commerce, Springfield, Va., 22151

# **SELECTED WATER RESOURCES ABSTRACTS**

A Semimonthly Publication of the Water Resources Scientific Information Center,  
Office of Water Resources Research, U.S. Department of the Interior



Water Resources Abstracts is a publication of the Water Resources Scientific Information Center, Office of Water Resources Research, U.S. Department of the Interior.

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**VOLUME 2, NUMBER 8**  
**APRIL 15, 1969**

**WR 69-02801 -- WR 69-03200**

SELECTED

## WATER RESOURCES ABSTRACTS

A Bimonthly Abstract containing abstracts of literature on water resources, prepared by the Water Resources Research Institute, U.S. Geological Survey.

As the Nation's principal conservation agency, the Department of the Interior has basic responsibilities for water, fish, wildlife, mineral, land, park, and recreational resources. Indian and Territorial affairs are other major concerns of America's "Department of Natural Resources."

The Department works to assure the wisest choice in managing all our resources so each will make its full contribution to a better United States—now and in the future.

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### FOREWORD

**Selected Water Resources Abstracts**, a semimonthly journal, includes abstracts of current and earlier pertinent monographs, journal articles, reports, and other publication formats. The contents of these documents cover the water-related aspects of the life, physical, and social sciences as well as related engineering and legal aspects of the characteristics, conservation, control, use, or management of water. Each abstract includes a full bibliographical citation and a set of descriptors or identifiers which are listed in the **Water Resources Thesaurus** (November 1966 edition). Each abstract entry is classified into ten fields and sixty groups similar to the water resources research categories established by the Committee on Water Resources Research of the Federal Council for Science and Technology.

Sufficient bibliographic information is given to enable readers to order the desired documents from local libraries or other sources. WRSIC is not presently prepared to furnish loan or retention copies of the publications announced.

**Selected Water Resources Abstracts** is designed to serve the scientific and technical information needs of scientists, engineers, and managers as one of several planned services of the Water Resources Scientific Information Center (WRSIC). The Center was established by the Secretary of the Interior and has been designated by the Federal Council for Science and Technology to serve the water resources community by improving the communication of water-related research results. The Center is pursuing this objective by coordinating and supplementing the existing scientific and technical information activities associated with active research and investigation program in water resources.

To provide WRSIC with input, selected organizations with active water resources research programs are supported as "centers of competence" responsible for selecting, abstracting, and indexing from the current and earlier pertinent literature in specified subject areas. Centers, and their subject coverage, now in operation are:

- Ground and surface water hydrology at the Water Resources Division of the U.S. Geological Survey, U.S. Department of the Interior.
- Metropolitan water resources management at the Center for Urban Studies of the University of Chicago.
- Eastern United States water law at the College of Law of the University of Florida.
- Policy models of water resources systems at the Department of Water Resources Engineering of Cornell University.
- Water resources economics at the Water Resources Research Institute of Rutgers University.
- Design and construction of hydraulic structures; weather modification; and evaporation control at the Bureau of Reclamation, Denver, Colorado.
- Eutrophication at the Water Resources Center of the University of Wisconsin.
- Water resources of arid lands at the Office of Arid Lands Studies of the University of Arizona.

The input from these Centers, and from the 51 Water Resources Research Institutes administered under the Water Resources Research Act of 1964, as well as input from the grantees and contractors of the Office of Water Resources Research and other Federal water resources agencies with which the Center has agreements becomes the information base from which this journal is, and other information services will be, derived; these services include bibliographies, specialized indexes, literature searches, and state-of-the-art reviews.

Comments and suggestions concerning the contents and arrangement of this bulletin are welcome.

Water Resources Scientific  
Information Center  
Office of Water Resources Research  
U.S. Department of the Interior  
Washington, D. C. 20240

# SELECTED WATER RESOURCES ABSTRACTS

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#### 02 WATER CYCLE

Includes the following Groups: General; Precipitation; Snow, Ice, and Frost; Evaporation and Transpiration; Streamflow and Runoff; Groundwater; Water in Soils; Lakes; Water in Plants; Erosion and Sedimentation; Chemical Processes; Estuaries.

#### 03 WATER SUPPLY AUGMENTATION AND CONSERVATION

Includes the following Groups: Saline Water Conversion; Water Yield Improvement; Use of Water of Impaired Quality; Conservation in Domestic and Municipal Use; Conservation in Industry; Conservation in Agriculture.

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Includes the following Groups: Control of Water on the Surface; Groundwater Management; Effects on Water of Man's Non-Water Activities; Watershed Protection.

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# SELECTED WATER RESOURCES ABSTRACTS

## 01. NATURE OF WATER

### 1B. Aqueous Solutions AND Suspensions

#### GRAPHICAL METHODS FOR STUDIES OF AQUEOUS ALUMINUM HYDROXIDE, FLUORIDE, AND SULFATE COMPLEXES, Geological Survey, Washington, D.C.

J. D. Hem.

U.S. Geol. Surv. Water-Supply Pap. 1827-B, 33 p., 1968. 18 fig., 3 tab., 14 ref.

Descriptors: \*Water chemistry, \*Aluminum, \*Thermodynamic behavior, \*Mathematical studies, Fluorides, Sulfates, Stability, Equilibrium, Aqueous solutions.

Identifiers: \*Equilibrium calculations, \*Graphical methods, Chemical complexes.

Published stability constants show that aluminum forms strong complexes with hydroxide, fluoride, and sulfate ions. This paper presents equilibrium calculations which show that fluoride complexes probably will be the predominant form of aluminum solute species in natural water below neutral pH, when more than a few tenths of a part per million of fluoride is present. Sulfate complexes of aluminum can be important below neutral pH if sulfate concentrations exceed 500 ppm. The predominant complex species and proportion of uncomplexed aluminum activity to total aluminum concentration are shown graphically as functions of the analytical concentration of aluminum and fluoride, or sulfate, for ionic strengths ranging from zero to that of sea water. In alkaline solutions the species Al(OH)<sup>-4</sup> tends to predominate. The forms of aluminum complexes which can be expected to predominate, and extent of complexing in solutions containing both fluoride and sulfate, and the effects of pH on the complexing of aluminum by fluoride and sulfate are given graphically. (Steinbauer-USGS)

W69-02834

## 02. WATER CYCLE

### 2A. General

#### LOW-FLOW AND BASIN CHARACTERISTICS OF TWO STREAMS IN NORTHERN VERMONT,

Agricultural Research Service, Danville, Vt. Soil and Water Conservation Research Div.

G. H. Comer, and R. C. Zimmerman.

J. Hydrol., Vol. 7, (1969), No. 1, pp. 98-108, Nov. 1968. 11 p., 3 fig., 4 tab., 14 ref.

Descriptors: \*Small watersheds, \*Rainfall-runoff relationships, \*Vermont, Glacial soils, Duration curves, Land use, Topography, Organic soils, Infiltration, Storage.

Identifiers: Fragipans, Experimental watersheds.

During a 6-yr period, the minimum flows per unit of area in a 3.2 sq-mi basin of northern Vermont were 0.000027 in/h compared with 0.00003 in/h in an adjacent 8.4-sq-mi basin. As the climate, geology, and land use in the two basins are similar, the differences in low flow are probably caused by differences in topography and in soils. Fifty-four percent of the larger, low-yielding basin has slopes of 8% or less; slopes of 8% or less occur in only 28% of the smaller basin. Poorly and very poorly drained fragipan soils (Typic and Humic Fragiaquepts) occupy 44% of the larger basin, as opposed to only 22% of the smaller, steeper basin. These soils have an O horizon, and A horizon with high organic content, and a fragipan at depths generally between 12 and 18 in. Their effect is to retard or impede deep percolation to storage, and to retain moisture in the surficial horizons even at high tensions. In the smaller basin, high base flow is probably sustained by the slow release of moisture from the deeper, surficially well-drained soils that prevail in it.

W69-02814

#### INTERRELATIONSHIP BETWEEN PHYSIOGRAPHY, HYDROLOGY, SEDIMENTATION, AND SALINIZATION OF THE LODDON RIVER PLAINS, AUSTRALIA,

Geological Survey of Australia, Melbourne. For primary bibliographic entry see Field 02B. For abstract, see .

W69-02817

#### AVAILABILITY OF GROUND WATER IN THE PARTS OF THE ARLINGTON AND WICKLIFFE SW QUADRANGLES IN JACKSON PURCHASE REGION, KENTUCKY,

Geological Survey, Washington, D.C.

R. W. Davis.

U.S. Geol. Surv. Hydrol. Invest. Atlas HA-183, 1 sheet, 1968. Text, geol. sec., 1 ref.

Descriptors: \*Water resources, \*Groundwater, \*Kentucky, Water wells, Hydrologic data, Aquifers, Water quality, Water yield.

Identifiers: Wickliffe and Arlington Quadrangles (Ky.).

The availability of groundwater in the parts of the Arlington and Wickliffe SW quadrangles in the Jackson Purchase region of western Kentucky is reported in an Atlas sheet containing a map showing availability of groundwater, location of wells, and quality of water, a columnar section showing stratigraphy and water bearing character of formations, and geologic cross sections showing water table elevations, and a short text. Sufficient supplies of groundwater for domestic, public, and industrial needs are available. All present development is from alluvium and a shallow Eocene aquifer; a deeper Eocene aquifer capable of yielding larger amounts is untapped. The largest well in the area yields 415 gpm. The quality of the groundwater is good, commonly less than 200 ppm dissolved solids. The shallow Eocene aquifer contains water that varies from hard near the Mississippi River, the western part of the area, to soft in the east. Iron content is less than 0.3 ppm. (Knapp-USGS)

W69-02822

#### HYDROLOGIC STUDIES OF SMALL WATERSHEDS IN AGRICULTURAL AREAS OF SOUTHERN MICHIGAN,

Geological Survey, Lansing, Mich.; Michigan State Univ., East Lansing; and Environmental Sciences Services Administration, East Lansing, Mich.

N. D. Strommen, R. L. Knutilla, and C. Mueller.

Mich. Water Resources Comm. Rep. No 3, 191 p., July 1968. 15 fig., 16 tab., 2 ref.

Descriptors: \*Data collections, \*Streamflow, \*Precipitation (Atmospheric), \*Small watersheds, \*Michigan, Rain gages, Runoff, Rainfall-runoff relationships, Hydrographs.

Identifiers: Southern Michigan (Ingham County), Deer-Sloan Creek Watershed.

To provide necessary data for use in the designing of drainage and water control facilities on small watersheds, a dense network of rain gages was installed on the Deer-Sloan Creek Watershed during April 1956 in Ingham County, Michigan. Because the relatively level to gently rolling terrain provides little orographic influence on the weather patterns in the area, the data obtained should be representative for much of southern Michigan. The report consists of two basic sections. The first, prepared by U.S. Geological Survey, deals with streamflow characteristics (1954-1964) and streamflow data (1954-1966) for the Deer and Sloan Creeks. The final section presents tabulated monthly summary precipitation data for the period 1956 through 1967. (Knapp-USGS)

W69-03045

#### RUNOFF AND HILLSLOPE EROSION RESULTING FROM A HIGH-INTENSITY THUNDERSTORM NEAR MACK, WESTERN COLORADO,

Geological Survey, Denver, Colo.

Richard F. Hadley, and Gregg C. Lusby.

Water Resources Res., Vol. 3, No. 1, pp. 139-143, 1967. 5 p., 3 fig., 8 ref.

Descriptors: \*Rainfall intensity, \*Runoff, \*Erosion, Sediment yield, Infiltration, Rainfall-runoff relationships, Colorado.

Data on hydrologic and geomorphic processes from single storm events are rare, but the opportunity to make such measurements occurred on August 12, 1964, when the runoff and hillslope erosion resulting from a high-intensity thunderstorm were measured in a small basin of 12 acres in western Colorado. The maximum intensity of rainfall for a 10-min period was 1.98 in. per hr. The total runoff as measured in a reservoir was 0.508 in. over the basin, and 0.90 in. of precipitation had been recorded when runoff stopped. Data from measurements of erosion pins along 6 hillslope profiles indicate that approximately 0.11 acre-foot was eroded from the basin during the storm; survey of the reservoir shows that 0.090 acre-foot was delivered to the lower end of the basin. Estimates of soil loss using measurements of erosion pin exposure are considered to be good in basins where sediment transport from hillslopes to the measuring point is not complicated by diverse topography or intermediate areas where deposition may occur. (Knapp-USGS)

W69-03052

#### EFFECTS OF CLIMATOLOGIC AND BASIN CHARACTERISTICS ON ANNUAL RUNOFF,

Board of Agriculture, Helsinki (Finland).

Seppo E. Mustonen.

Water Resources Res., Vol. 3, No. 1, pp. 123-130, 1967. 8 p., 2 fig., 3 tab., 9 ref.

Descriptors: \*Climatology, \*Synoptic analysis, \*Watersheds (Basins), \*Rainfall-runoff relationships, Statistical methods, Regression analysis, Precipitation (Atmospheric), Temperature, Soils, Vegetation, Frost.

Identifiers: Finland, Drainage basin characteristics.

Climatologic and basin characteristics affecting the annual runoff in Finland are selected by the orthogonal regression method. Climatologic variables, especially seasonal precipitation and mean annual temperature, are found to be much more important than basin characteristics such as soil type and vegetation. Frost depth is inversely related to annual runoff. The percentages of cultivated land and peat land are not significant variables in these data. The simple linear multiple regression approach was successful ( $R = 0.943$ ,  $s_0 = 34 \text{ mm}$ ) in developing a reliable prediction equation. However, no statistical procedure can uncover the underlying laws governing runoff until the basic physical relationships are better understood. Furthermore, most available climatologic and basin characteristics are only indices of the combined effects of several physical factors. Hence, the utility of some of the more complex statistical approaches is questionable. (Knapp-USGS)

W69-03055

#### INFILTRATION, OVERLAND FLOW, AND SOIL MOVEMENT ON FROZEN AND SNOW-COVERED PLOTS,

Forestry Sciences Lab., Moscow, Idaho.

Harold F. Haupt.

Water Resources Res., Vol. 3, No. 1, pp. 145-161, 1967. 17 p., 7 fig., 4 tab., 19 ref.

Descriptors: \*Frost, \*Frozen ground, \*Snowpacks, \*Slopes, \*Rainfall-runoff relationships, Infiltration, California.

Identifiers: Sierra Nevada.

A small plot study shows how ground cover, furrowing, and the presence of frost in soils of the Sierra Nevada affect infiltration from prolonged

## Field 02—WATER CYCLE

### Group 2A—General

simulated winter rains. A rapidly melting snowpack over soil containing dense frost may accelerate on-site runoff. The presence of stalactite soil frost promotes rapid absorption of snowmelt and reduces overland flow. Conversely, porous concrete frost usually reduces infiltration capacity and increases overland flow on burned or sparsely vegetated sites but does not impair infiltration where plant and litter cover are appreciable. Snow cover, by cooling rain water, tends to preserve soil frost and keep it visibly intact. Snow absorbs raindrop energy much as dense vegetation does. Soil losses from snow-covered plots, regardless of vegetative cover, are practically nil. Generally, plants, litter and snow cover dissipate raindrop energy and increase infiltration, but exposed rock usually accelerates overland flow and erosion. Shallow contour furrowing seemed to facilitate infiltration and controlled over-land flow adequately. (Knapp-USGS) W69-03060

#### ANALYTICALLY DERIVED UNIT GRAPH AND RUNOFF,

Tennessee Valley Authority, Knoxville.

Roger P. Betson, and Ralph F. Green.

ASCE Proc, J Hydraul Div, Vol 94, No Hy6, Pap 6256, pp 1489-1505, Nov 1968. 17 p, 6 fig, 2 tab, 11 ref.

Descriptors: \*Mathematical models, \*Unit hydrographs, \*Synthetic hydrology, Rainfall-runoff relationships, Digital computers, Computer programs, Optimization, Methodology.

Identifiers: \*Fitting technique, Effective rainfall.

A technique has been programmed to solve analytically for measures of precipitation excess and unit graph shape parameters. The optimization procedures achieved a very high degree of adjustment of the model to data, but the results were inconsistent. The paper describes the development of an objective fitting technique. A two-step fitting procedure was devised which substantially increased the objectivity of the fitting technique. The two shape parameters were first individually corrected by a univariate technique to near-optimum values. This reduced the effect of the higher-order partial derivatives with respect to the shape parameters. The simultaneous differential correction technique was then used to obtain corrections for both the shape parameters and the runoff parameters. While this two-step solution technique does not quite yield exact results, they are close enough to the desired values and can be obtained consistently from different starting points. (Knapp-USGS) W69-03069

#### AN EXPERIMENTAL RAINFALL-RUNOFF FACILITY,

Colorado State Univ., Fort Collins.

W. T. Dickinson, M. E. Holland, and G. L. Smith. Colo State Univ Hydrol Pap No 25, 81 p, Sept 1967. 13 fig, 4 tab, 29 ref. OWRR Proj No. B-005-COLO.

Descriptors: \*Rainfall-runoff relationships, \*Model studies, Mathematical models, Hydraulic models, Bibliographies, Colorado.

Identifiers: \*Experimental rainfall-runoff plot, Rainfall simulation.

An experimental facility for the investigation of the rainfall-runoff relationship was constructed. It is large enough to respond like a prototype watershed and small enough to study conveniently. The shape was designed to be like a generalized model derived from study of 61 natural small watersheds with a range in drainage area from 0.11 sq mi to 0.97 sq mi. The facility has a length of 285 ft, a length to width ratio of 1.8 to 1 and an area of about 44,000 sq ft. The mean slope is about 5%. Precipitation is simulated by nozzles on a tower. The site geometry and the data collecting and handling equipment are described in detail. The literature of mathematical models of hydrological watershed response is criti-

cally reviewed and an annotated bibliography of 226 references is included. (Knapp-USGS) W69-03076

#### RAINFALL INTENSITY AND ELEVATION IN SOUTHWESTERN IDAHO,

Michigan Univ., Ann Arbor.

For primary bibliographic entry see Field 02B.

For abstract, see .

W69-03087

#### MOMENTS OF THE INPUT, OUTPUT, AND IMPULSE RESPONSE FUNCTIONS OF LINEAR SYSTEMS ABOUT ARBITRARY POINTS,

Technion-Israel Inst. of Tech., Haifa; and Water Planning for Israel Ltd., Tel-Aviv.

M. H. Diskin, and A. Boneh.

Water Resources Res, Vol 4, No 4, pp 727-735, Aug 1968. 9 p, 4 fig, 5 ref.

Descriptors: \*Watershed (Basins), \*Rainfall-runoff relationships, \*Runoff, Synthesis, Time lag, Mathematical studies, Methodology.

Identifiers: \*Linear time invariant systems, \*Impulse response functions, Surface hydrology.

Consideration is given to the problem of the general relationship between the moments of three functions related by the convolution integral about any three arbitrary points (a,b,c,) on the time axis. One of the most important problems in surface hydrology is determining the impulse response function of a watershed system from historical records of rainfall excess and direct surface runoff, which are respectively the input and output of the watershed system. A useful approach to determining the shape of the impulse response function is, assuming the system to be linear, to use a moments theorem that relates the moments of the three functions. A general expression is derived for the relation between the moments of the systems about any three arbitrary points along the time axis. The derivation is given both by a method based on integration and summation operations, and by a method using Laplace transforms. The latter method also gives the influence on their output of initial time lags in the input and in the impulse response function of linear systems. (Llaverias-USGS)

W69-03089

#### RELATIONSHIP BETWEEN PRECIPITATION, EVAPORATION, AND RUNOFF IN TROPICAL-EQUATORIAL REGIONS,

Shawinigan Engineering Co. Ltd., Montreal (Quebec).

S. Solomon.

Water Resources Res, Vol 3, No 1, pp 163-172, 1967. 10 p, 7 fig, 17 ref.

Descriptors: \*Hydrologic budget, \*Tropical regions, \*Evaporation, Rainfall-runoff relationships, Radiation, Lakes, Reservoir evaporation, River basins.

Identifiers: \*Potential evaporation, Water budget, Bouchet's theory.

Methods for calculating water budgets of drainage basins are reviewed with particular attention to the calculation of evaporation. Bouchet's theory on actual and potential evaporation can be used as a basis to develop semi-empirical relationships between precipitation, actual evaporation, and radiation. These relationships are curvilinear, and the derived precipitation-runoff relationships are also curvilinear. Since the variation of annual radiation from one year to another in tropical-equatorial regions is not very significant, the average value of annual radiation can be approximated using direct measurements or indirect estimates from data taken over a period of from two to five years. This value can be used with the semi-empirical relationship developed to obtain fair estimates of the annual variation of actual evaporation and runoff from data on annual precipitation and good estimates of the long-term averages of these hydrologic

characteristics. Bouchet's theory can be used to analyze evaporation and runoff for periods of less than one year and for estimating lake and reservoir evaporation. However, in this case, the assessment of the effect of heat and moisture storage requires further investigation.

W69-03092

#### DEPLETION OF FLOW IN RIGHT-ANGLE STREAM BENDS BY STEADY WELLS,

New Mexico Tech., Socorro.

Mahdi S. Hantush.

Water Resources Res, Vol 3, No 1, pp 235-240, 1967. 6 p, 1 fig, 1 tab, 15 ref.

Descriptors: \*Surface-groundwater relationships, \*Induced infiltration, \*Water wells, Streamflow, Discharge (Water), Pumping, Artesian wells Water table.

Identifiers: \*River depletion.

The flow of a stream that is hydraulically connected to an aquifer can be reduced considerably by nearby pumping wells. Pumping such wells will either increase the infiltration from the nearby streams or decrease the natural groundwater flow that would have discharged into the streams if the wells had not been pumped, or effect both processes at the same time. The depletion of the streamflow is an increase to the perennial yield of the sand. Consequently, greater supplies of water can be obtained than would be available as groundwater alone in such systems. Natural as well as artificial streams meeting at approximately right angles are not uncommon in nature. Irrigation and drainage canals, and streams having a trellis drainage pattern, are examples of such an occurrence. Wells for domestic as well as for irrigation use are often installed near such streams. Rational estimates of the rate of depleting such streams by the nearby pumping wells are therefore of practical interest. Formulas for estimating the rate and volume of stream depletion in such systems are developed in terms of extensively tabulated functions.

W69-03094

#### REVIEW AND ANALYSIS OF RAINFALL AND RUNOFF DATA FOR SELECTED WATERSHEDS IN MINNESOTA,

Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.

C. Edward Bowers, and Arthur F. Pabst.

Water Resources Res Center Bull No 8, Dec 1968. 70 p, 55 fig, 9 tab, 10 ref.

Descriptors: \*Rainfall-runoff relationships, \*Watersheds, \*Optimization, Frequency analysis, Unit hydrographs, Computer programs, Floods, Hydrographs, Minnesota, Infiltration, Structures, Design data.

Identifiers: Depression storage, Design runoff.

Available rainfall and runoff data for selected watersheds in Minnesota were analyzed to aid in the evaluation of peak runoff rates for design purposes. Analysis of data from 51 flood events in five watersheds was aided by an optimization program prepared by U.S. Army Corps of Engineers Hydrologic Engineering Center. This program was used to optimize nine variables associated with the watersheds, to develop characteristic unit hydrographs, and to evaluate loss rates for the watershed in terms of the mathematical model represented by the optimization program. Data on annual maximum floods as well as maximum summer floods were plotted on log-probability paper and theoretical flood-frequency curves determined by the log-Pearson Type 3 distribution. Hourly loss rates were quite high for the watersheds used in this study. The shape of unit hydrographs developed for the larger watersheds was affected considerably by storm pattern and storm location, and to some extent by storm direction. (Steinhilber-USGS) W69-03098

**HYDROLOGY AND WATER RESOURCES OF THE Housatonic River Basin, Massachusetts,**  
Geological Survey, Washington, D. C.  
Ralph F. Norvitch, Donald F. Farrell, and Felix H. Pauszek.  
U S Geol Surv Hydrol Invest Atlas HA-281, 4 sheets, 1968. 20 fig, 6 map, 10 tab, 20 ref.

Descriptors: \*Water resources, \*Watersheds (Basins), \*Hydrology, Water yield, Water quality, Hydrologic budget, Surface waters, Groundwater, Water utilization, Reservoir storage, Massachusetts.  
Identifiers: Housatonic River basin (Mass.).

Water resources and water problems of the Upper Housatonic River basin are described on four sheets of a hydrologic atlas. Data are presented on the water budget and on the occurrence, availability, quality, and use of surface and groundwaters in the basin. Information presented shows that large quantities of water are available for development by impounding tributary streams within the hills bordering the valley. Also, additional quantities of good-quality water are available from groundwater sources in several places within the valley. The Housatonic River, the largest stream in the valley, is highly polluted and not fit for human consumption without treatment.  
W69-03101

**SOME ERROR PROPERTIES OF SEGMENTED HYDROLOGIC FUNCTIONS,**  
Georgia Inst. of Tech., Atlanta.  
For primary bibliographic entry see Field 07C.  
For abstract, see .  
W69-03105

**SLOPE LENGTH OF CLAYPAN SOIL AFFECTS RUNOFF,**  
Agricultural Research Service, Columbia, Mo.; and Agricultural Research Service, Urbana, Ill.  
V. C. Jamison, and D. B. Peters.  
Water Resources Res, Vol 3, No 2, pp 471-480, 1967. 10 p, 6 fig, 3 tab, 8 ref.

Descriptors: \*Runoff, \*Irrigation, \*Infiltration, \*Subsurface runoff, \*Recession curves, Slopes, Rainfall-runoff relationships.  
Identifiers: Claypan soils, Slope length.

Measurements of runoff after prolonged irrigation of grass plots on a claypan soil (Mexico silt loam) showed that recession yields per unit area increased with slope length. Yields from slopes of lengths varying from 76 to 323 ft indicated return flow or interflow during runoff recession of at least 0.1 in. from the longer plots. During a simulated wet season using irrigation to supplement rainfall in the summer of 1965, per unit area yields were greatest for long plots, except for small events or events of long duration. The seasonal yield was 1.69 in., or about 19% more from the long than from the short plots. Hydraulic conductivity measurements indicate that the predominant path of interflow is in the upper in. or two of the soil surface. However, soil moisture content and hydraulic pressure gradient changes during recession runoff indicated that there may be an interflow contribution from the loessial soil layer between weathered till and claypan.  
W69-03106

**THE HYDRAULICS OF OVERLAND FLOW ON HILLSLOPES,**  
Geological Survey, Washington, D. C. Water Resources Div.  
For primary bibliographic entry see Field 02E.  
For abstract, see .  
W69-03110

**CONTROL LEVELS FOR QUANTITATIVE EVALUATION OF WEATHER MODIFICATION ATTAINMENTS,**  
Colorado State Univ., Fort Collins.

Radmilo D. Markovic.  
Water Resources Res, Vol 3, No 2, pp 423-431, 1967. 9 p, 3 fig, 4 tab, 8 ref.

Descriptors: \*Evaluation, \*Weather modification, Cloud seeding, Precipitation (Atmospheric), Runoff, Streamflow, Stream gages, Rain gages.

There are 3 basic control levels from which the quantitative statistical evaluation of cloud seeding weather modification attainments can be considered, corresponding to three particular stages in the general hydrologic cycle: cloud phenomena, precipitation, and river flow control levels. The cloud phenomena level of control is suitable for qualitative physical rather than for quantitative statistical evaluation of weather modification attainments. The precipitation level of control may be used for both qualitative and quantitative evaluations. However, the inaccuracy involved in single measurements of precipitation under different environmental conditions and in the determination of mean areal precipitation makes this level of control unreliable for the quantitative evaluation of weather modification attainments at present. The river flow control level has been shown to be suitable and promising, accurate, and reliable for practical purposes, and it is, therefore, highly recommended for use in the quantitative evaluation of weather modification attainments.  
W69-03113

**FLOW OF GROUNDWATER ADJACENT TO SMALL, CLOSED BASINS IN GLACIAL TILL,**  
Idaho Univ., Moscow.  
For primary bibliographic entry see Field 02F.  
For abstract, see .  
W69-03119

**A LAPLACE TRANSFORM PROOF OF THE THEOREM OF MOMENTS FOR THE INSTANTANEOUS UNIT HYDROGRAPH,**  
Technion Israel Inst. of Tech., Haifa.  
For primary bibliographic entry see Field 06A.  
For abstract, see .  
W69-03120

## 2B. Precipitation

**INFLUENCE OF THE FOREST ON PRECIPITATION,**  
State Hydrological Inst., Leningrad (USSR).  
S. F. Fedorov, and A. S. Burov.

Translated from Trudy Gos Gidrol Inst, No 142, pp 8-19, 1967. Soviet Hydrol Selec Pap (AGU), No 3, pp 217-227, 1967. 11 p, 1 fig, 8 tab, 20 ref. 3 append.

Descriptors: \*Precipitation (Atmospheric), \*Forests, \*Vegetation effects, Microclimatology, Precipitation gages, Rain gages, Permeability, Infiltration, Soil moisture.  
Identifiers: USSR, Forest effect on atmospheric precipitation.

Experiments by the Valdai Hydrological Scientific Research Laboratory on the differences in precipitation on forests and open areas lead to the conclusion that a forest promotes an increase in precipitation of 10-15%. Analysis of the effect of surface roughness on precipitation yields a similar result. Average warm season (June-October) precipitation was measured by closely spaced rain gages located in areas with different ground surfaces, in spruce forest, in a deciduous forest, and in an experimental evaporation plot in a meadow. The greatest precipitation was in the spruce forest, somewhat lower in the deciduous forest, and the lowest in the meadow. The data are tabulated. (Knapp-USGS)  
W69-02803

**INTERRELATIONSHIP BETWEEN PHYSIOGRAPHY, HYDROLOGY, SEDIMENTATION, AND SALINIZATION OF THE LODDON RIVER PLAINS, AUSTRALIA,**  
Geological Survey of Australia, Melbourne.

P. G. Macumber.

J Hydrol, Vol 7, (1969), No 1, pp 39-57, Nov 1968. 19 p, 5 fig, 1 plate, 2 tab, 18 ref.

Descriptors: \*Saline soils, \*Saturated soils, \*Land reclamation, \*Drainage, \*Irrigation practices, Flood control, Leaching, Alluvium, Water table.  
Identifiers: Australia, Loddon River, Aeolian soils.

The causes of salinization of the Loddon River plain, Australia, were studied to attempt to find a means of halting the deterioration of irrigated farms and grazing land. The pattern of salinization was found to be closely linked to the fluvial and aeolian patterns of Quaternary sedimentation, with the most severe salinization in clays and fine soils. Flood control projects eliminated the winter sheet flood which leached salt from the upper soil profile each year, while summer irrigation causes rising water tables and soil salinization. Alluvial sand aquifers are found along some of the streams; pumping them heavily as groundwater drains can be done locally to lower the water table and alleviate soil salinity. Buried alluvial aquifers parallel to surface drainage were found and may also be pumped for drainage. (Knapp-USGS)  
W69-02817

**AN EVALUATION OF PRECIPITATION, VEGETATION AND RELATED FACTORS ON THE SANTA RITA EXPERIMENTAL RANGE,**  
Arizona Univ., Tucson. Inst. of Atmospheric Physics; and Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colo.  
Christine R. Green, and S. Clark Martin.  
Univ of Ariz, Inst Atmospheric Physics, Tech Repts Meteorology and Climatology of Arid Regions, No 17, pp 1-82, April 1967. 82 p, 18 fig, 5 tab.

Descriptors: Evaluation, \*Statistical methods, \*Rainfall, Precipitation (Atmospheric), Rain gages; Monthly, Annual, \*Analytical techniques, \*Data collections, Variability, \*Climatic data, Regression analysis, Elevation, Seasonal, Correlation analysis, Crop response, Arid lands, Soil moisture.  
Identifiers: \*Santa Rita Experimental Range (Arizona).

Monthly and annual precipitation data for 45 rain gages over the Experimental Range were presented in this publication. The length of record for the 45 stations varied from 6 to 43 years. In the statistical analyses, a common 26-year period for 22 of the gages was used. The results were tabulated and presented graphically. The coefficient of variation provided the most satisfactory applied measure of variability for semidesert or desert precipitation. Product-moment correlations and stepwise multiple regression analyses were also calculated from the rainfall data comparing these with station elevation and location in respect to the eastern and southern peaks of the Santa Rita Mountains. The effectiveness of precipitation on vegetation and soil moisture in the area was discussed and the typical effects to be found within the Experimental Range were depicted by tables and graphs. (Affleck-Arizona)  
W69-02989

**HYDROLOGIC DATA: 1967 - VOLUME IV: SAN JOAQUIN VALLEY.**  
California Resources Agency. Dept. of Water Resources.  
For primary bibliographic entry see Field 02E.  
For abstract, see .  
W69-03068

**RAINFALL INTENSITY AND ELEVATION IN SOUTHWESTERN IDAHO,**  
Michigan Univ., Ann Arbor.  
Charles F. Cooper.  
Water Resources Res, Vol 3, No 1, pp 131-137, 1967. 7 p, 4 fig, 2 tab, 7 ref.

Descriptors: \*Rainfall intensity, \*Elevation, \*Mountains, \*Idaho, \*Frequency analysis, Thunderstorms.

## Field 02—WATER CYCLE

### Group 2B—Precipitation

There is no apparent relationship between elevation and the intensity of spring and summer rainfall in a 93-sq-mi area with a range of 3,500 ft in elevation in semiarid southwestern Idaho. Analysis covered 4 years' data from recording rain gages with an average density of 1 per sq mi. Rainfall bursts amounting to 0.10 in. or more are considered. The maximum intensity recorded was 0.49 in. falling at 9.8 in. per hr. Rainfall in excess of 0.8 in. per hr occurred an average of once a yr. The logarithm of the amount of rain falling in excess of a given intensity plots as a straight line against intensity. There is no difference in this relationship when the data are separated by elevation classes. The amount of rainfall decreases by about 1/2 with each 1-in.-per-hr increase in rainfall rate. This ratio may be a characteristic of the regional climate. It is suggested that data from accessible valley stations can be used to estimate the relative frequency of high intensity rains throughout an area of appreciable range in elevation.

W69-03087

**UNITED STATES TRITIUM RAINOUT AND ITS HYDROLOGIC IMPLICATIONS,**  
Geological Survey, Washington, D. C.  
G. L. Stewart, and R. K. Farnsworth.  
Water Resources Res., Vol 4, No 2, pp 273-289,  
April 1968. 9 fig, 2 tab, 7 ref.

Descriptors: \*Tritium, \*Tracers, \*Radioactivity, Water quality, Precipitation, Tagging, Radioactive dating.  
Identifiers: \*Tritium rainout, Isotopes.

Information on tritium input to the hydrological environment is necessary before the tritium can be used as a tracer in hydrologic studies. Data are presented on tritium concentrations and tritium rainout for 1964 and 1965 at 15 precipitation stations in conterminous United States, Alaska, and Puerto Rico. These data show that the major increase in tritium rainout observed in 1963 was followed by noticeable declines during 1964 and 1965. Patterns of tritium rainout are characterized by increases in tritium rainout with northern latitudes and with distance from the oceans. The tremendous tritium pulse added to the hydrologic environment by nuclear devices can be useful in future hydrologic investigations, provided that caution is used in interpreting tritium data and that conclusions are based on sound hydrologic principles. The tritium data now available makes it possible to estimate present and past tritium input levels at any location in the United States with an accuracy sufficient for most practical hydrologic applications. (Steinhilber-USGS)

W69-03121

**SOCIAL IMPACT OF METEOROLOGICAL DROUGHT IN ILLINOIS,**  
Illinois Univ., Urbana. Dept. of Geography.  
Alfred W. Booth, and Don Voeller.  
Water Resources Center. Report no. 9, March 1967, Washington, D. C. 31 p, 12 ref. OWRR Project A-007-III.

Descriptors: \*Drought, \*Social impact of drought, \*Illinois.

Drought invariably infers a shortage of moisture in one context or another, wherein a situation of stress evolves; and attempts have been made to develop a procedure whereby the relative and absolute impact of this phenomenon can be measured. It was proposed to test the validity of meteorological drought, as defined by the recently derived Palmer Index, by comparing the variability of drought in Illinois, as indicated by the index, with the effects of this phenomenon on various sectors of the State's society. The research was based on the hypothesis that the impact of drought on the social realm varies as drought severity varies. Due primarily to the lack of long-term, readily available data and of developed methodology for isolating the effects of natural phenomenon on man and his activities, little conclusive objective evidence was obtained; however, it appears that drought has vari-

able impact: (1) from one sector of society to another at a given time, (2) within the same sector of society in given areas at a given time, (3) in given sectors of society through space, and (4) through time on society as a whole, all because of the dynamic nature of man's culture which enables him to better cope with the vagaries of nature on the one hand and results in his becoming more susceptible to them on the other.

W69-03193

### 2C. Snow, Ice, AND Frost

**INFILTRATION, OVERLAND FLOW, AND SOIL MOVEMENT ON FROZEN AND SNOW-COVERED PLOTS,**  
Forestry Sciences Lab., Moscow, Idaho.  
For primary bibliographic entry see Field 02A.  
For abstract, see .  
W69-03060

**RADIATION AND SNOWMELT ON A CLEAR-CUT WATERSHED,**  
Northeastern Forest Experiment Station, Durham, N. H.  
G. A. Federer.

Proc of 1968 Annu East Snow Conf, Boston, Mass, Vol 13, pp 28-42, Feb 1968. 5 fig, 4 tab, 7 ref.

Descriptors: \*Snowmelt, \*Surface runoff, \*Demonstration watershed, \*Clear-cutting, Energy budget, Albedo, Watershed management, Water yield, New Hampshire.

Identifiers: Hubbard Brook Experimental Watershed.

Daily snowmelt on a clearcut watershed in central New Hampshire was estimated by using the energy balance. In melt periods, net solar radiation provided sufficient energy for melt and a small amount of evaporation; heat gain by convection was about equal to loss by net longwave radiation. Great spatial variation in slash density caused corresponding variation in net radiation and snowmelt. Clear-cutting did not advance snowmelt runoff very much in spite of large quantities of slash. Apparently the slash-covered watershed behaves quite similarly to the forested watershed in melt rate. (Knapp-USGS)  
W69-03078

**VELOCITY OF COMPRESSIVE WAVES IN POROUS MEDIA AT PERMAFROST TEMPERATURES,**  
Chevron Research Co., La Habra, Calif.

A. Timur.  
Geophys, Vol 33, No 4, pp 584-595, Aug 1968. 6 fig, 2 tab, 17 ref.

Descriptors: \*Permafrost, \*Porous media, Geophysics, Seismic properties, Subsurface investigations, Intertices.

Identifiers: Acoustic logging, Seismic exploration.

Data is presented on compressional wave propagation in frozen rocks as an aid in seismic exploration and acoustic log interpretation in permafrost. Velocity measurements were made of compressional waves in consolidated porous media within a temperature range of 26-36 deg C. The data indicate that compressional wave velocity increases with decreasing temperature in water-saturated rocks, whereas the velocity is nearly independent of temperature in dry rocks. Also the shapes of the velocity-temperature curves are functions of lithology, pore structure, and the nature of the interstitial fluids. Above the cryohydric temperature, compressional wave velocities may be estimated by using a three-phase, time-average equation; whereas below the cryohydric temperature, a two-phase, time-average equation may be used. Limited field data for compressional wave velocities in permafrost indicate that pore spaces in permafrost contain not only liquid and ice, but also gas. Therefore, the nature and percentages of pore saturants

should be determined before making velocity estimates with the time-average equations. (Steinhilber-USGS)  
W69-03090

### 2D. Evaporation and Transpiration

**PREDICTING DISSOLVED OXYGEN CONCENTRATION IN A LAKE COVERED WITH EVAPORATION SUPPRESSANT,**  
Bovay Engineers, Inc., Houston, Tex.

M. T. Amad.  
J Water Pollut Contr Federation, Vol 40, No 11, Part 2, pp R423-R433, Nov 1968. 11 p, 4 fig, 1 tab, 13 ref.

Descriptors: \*Dissolved oxygen, \*Monomolecular films, \*Evaporation control, \*Lakes, Hexadecanol, Octadecanol, Diffusion, Biodegradation, Environmental engineering.  
Identifiers: \*Oxygen balance, Evaporation suppressant.

An experimental and theoretical study undertaken to evaluate the diffusion of oxygen into water from the atmosphere through a monomolecular film of an evaporation suppressant (Hexadecanol-octadecanol mixture) under quiescent conditions revealed that the oxygen-uptake rate of organisms in a body of water can be measured and then introduced into a mathematical equation to predict the lowest dissolved oxygen concentration in the water during the early morning hours when the oxygen concentration is most critical. The oxygen-transfer rates in distilled water at 21 degrees and 36C treated with suppressant were 74 and 84%, respectively, of rates in untreated distilled water. Water from a pond containing 194 mg/l dissolved solids that was treated with suppressant showed 89.6 and 92.6% of the rate coefficients for untreated water at 21 and 36C, respectively. The temperature dependence of the diffusion coefficient can be expressed as  $(K_{sub t} = K_{sub 20}) times a constant to the power (t-20)$ ; the constant is 1.047 for untreated water and 1.053 for treated water. Theoretical and measured values for minimum DO agreed closely. (Knapp-USGS)  
W69-02825

**THE CONCEPT OF POTENTIAL EVAPOTRANSPIRATION IN ARID ZONE AGRICULTURE,**  
National and Univ. Inst. of Agriculture, Rehovoth (Israel).

G. Stanhill.  
Unesco Arid Zone Research, Vol 25, pp 109-117, 1965. 9 p, 5 fig, 2 tab, 28 ref.

Descriptors: \*Evapotranspiration, \*Meteorological data, Evaporation, Water loss, \*Evaporation pans, Water requirements, \*Agriculture, \*Arid climates, Crop response, Moisture deficit, Irrigation efficiency, Soil moisture, Vapor pressure, Measurement, Microenvironment.  
Identifiers: Penman's formula, Agrometeorology, Potential evapotranspiration.

An examination was made of the accuracy of eight widely used meteorological methods of estimation using data taken at Gilat in the arid region of southern Israel. The methods based on open water evaporation, either estimated from Penman's meteorological formula or measured in an evaporation tank, gave the most accurate estimate with the smallest error term. The use of Penman's formula was preferred since it offered the possibility of analysing the relative importance of various climatic factors in determining rate of water loss under nonlimiting soil moisture conditions. For agricultural purposes, use of measured or calculated open water evaporation with empirically derived reduction constants appeared to give the possibility of a practical and accurate method of irrigation control. (Blecker-Arizona)  
W69-02967

**Streamflow and Runoff—Group 2E**

**AN ELECTRIC HYGROMETER APPARATUS FOR MEASURING WATER-VAPOUR LOSS FROM PLANTS IN THE FIELD,**  
Western Australia Univ., Nedlands; and Botanic Gardens, St. Louis, Mo.  
B. J. Grieve, and F. W. Went.  
Unesco Arid Zone Research, Vol 25, pp 247-257, 1965. 11 p, 7 fig, 2 tab.

Descriptors: \*Hygrometry, \*Moisture content, Atmosphere, \*Water vapor, Humidity, \*Leaves, Instrumentation, \*Electrical equipment, Measurement, Desert plants, Weight, On-site tests, Plants, Boundary layers.

The sensing hygrometer apparatus described makes possible instantaneous determination of water-vapor loss using leaves intact on the plant. A better estimation of over-all daily water-vapor loss was possible since the speed of use allows numerous observations to be made on selected leaves in the course of a day. It is inherent in the electric hygrometer sensing method that the moving stream of air around the enclosed leaves disturbed the vapor shells or boundary layers. For field studies of water vapor loss involving comparison of rates in a number of character plants at a given station there were a number of advantages in the use of the electric hygrometer method over the cut and weigh method. (Blecker-Arizona)  
W69-02968

**ANTI-TRANSPIRANTS AS A RESEARCH TOOL FOR THE STUDY OF THE EFFECTS OF WATER STRESS ON PLANT BEHAVIOUR,**  
Hebrew Univ., Jerusalem (Israel). Dept. of Botany.  
For primary bibliographic entry see Field 03F.  
For abstract, see .  
W69-02986

**A NOTE CONCERNING THE EDDY TRANSFER COEFFICIENTS OF MOMENTUM AND WATER VAPOR UNDER NEAR-ADIABATIC CONDITIONS,**  
Geological Survey, Denver, Colo.  
G. Earl Harbeck, Jr.  
Water Resources Res, Vol 3, No 1, pp 201-202, 1967. 2 p, 1 tab, 5 ref.

Descriptors: \*Evaporation, \*Wind, \*Vapor pressure, \*Eddies, Turbulence, Temperature, Humidity.  
Identifiers: Eddy transfer coefficients.

Data from the Lake Hefner evaporation study of 1950-51 were used to compute the eddy transfer coefficient for momentum and the eddy transfer coefficient for water vapor. For approximately adiabatic conditions the 2 coefficients were found to be almost exactly equal. (Knapp-USGS)  
W69-03051

**EVAPORATION FROM LARGE DEEP LAKES,**  
Great Lakes-St. Lawrence Study Office, Cornwall (Ontario). Dept. of Mines and Technical Surveys.  
Fred I. Morton.  
Water Resources Res, Vol 3, No 1, pp 181-200, 1967. 20 p, 6 fig, 10 tab, 9 ref.

Descriptors: \*Evaporation, \*Lakes, \*Energy budget, Great Lakes, Limnology, Hydrology, Water budget, Radiation, Heat budget, Precipitation (Atmospheric), Temperature, Solar radiation.  
Identifiers: Lake Superior, Lake Ontario.

Derived insolation and water budget evaporation data for Lake Superior and Lake Ontario are analyzed in terms of both the regional and the water surface energy balances. The results indicate that the seasonal pattern of evaporation is governed by heat storage changes, and that these changes are closely associated with atmospheric energy export from the lake. This finding provides a physical basis for the simple empirical relationships between monthly evaporation and island-to-mainland temperature differentials that are developed from the water budget evaporation data.

Substantial atmospheric energy export, a concomitant of heat storage changes, reduces the energy available for evaporation. Therefore, evaporation from a large deep lake is less than that from a large shallow lake under comparable climatic conditions. The analysis also provides speculative reasoning and evidence to indicate that evaporation from a large deep lake is closely related to the radiant heat transfer to the sky.  
W69-03083

**A SIMPLE EVAPORIMETER FOR USE IN COLD AREAS,**  
Department of Agriculture, Summerland (British Columbia). Research Station.  
For primary bibliographic entry see Field 07B.  
For abstract, see .  
W69-03115

**THE EFFECT OF APPLIED INTERCEPTION ON TRANSPERSION RATES OF POTTED PONDEROSA PINE,**  
Arizona Univ., Tucson. Dept. of Watershed Management.  
For primary bibliographic entry see Field 02I.  
For abstract, see .  
W69-03116

**RELATION OF SOIL PROPERTIES TO THE EVAPORATION OF WATER FROM SOILS,**  
Clemson Univ., S. C. Agricultural Experiment Station.

T. C. Peele.  
Agronomy and Soils Research Series No. 70, Aug 1968. 20 p, 3 tab, 11 fig, 4 ref. OWRR Project A-006-SC.

Descriptors: \*Evaporation, \*Soil moisture, \*Soil properties, Moisture conservation, Cultivation, Bulk density, Soil texture, Soil physics.

Effects of texture, bulk density, and cultivation on evaporation of water from bare soils was investigated using tanks placed in the soil. Evaporation from sand, sandy loam, and sandy clay loam was higher than the evaporation from a U. S. Weather Bureau Class A Type Evaporation Pan during the first three days after wetting to 3 percent above field capacity. Cultivation three days after wetting caused a temporary increase in the rate of water loss followed by lower rates of water loss except from the sand. Cultivation had little effect on the rate of evaporation from the sand except the temporary increase immediately after cultivation. The moisture contents of the soils below the 2-inch depths were appreciably higher in the cultivated than the non-cultivated soils at the end of the 19-day drying period except the sand which showed little effect of cultivation on the moisture content below the 2-inch depth.  
W69-03175

**CORRELATING SOIL MOISTURE CONDITIONS AND MICROCLIMATE WITH EVAPORATION LOSSES AND WATER REQUIREMENTS OF PLANTS,**  
South Dakota State Univ., Brookings.

Maurice L. Horton.  
South Dakota Water Resources Research Institute. Research Project Technical Completion Report, September 1968. 11 p, 2 ref. OWRR Project A-005-SDak.

Descriptors: Solar radiation, Microclimate, \*Evapotranspiration, Lysimeter, Soil water.

Full utilization of water resources in crop production requires reliable information about the climate and the manner in which energy and water are used. Evapotranspiration is a basic parameter used in water resource planning and development that tends to reflect the availability of energy and water. Micrometeorological measurements made in an irrigated grain sorghum field provided information about the supply and distribution of energy and

water for a subhumid region in north central South Dakota. During the growing season, solar and sky radiation (Eppley) was 300 to 600 cal. cm. (-2) day (-1) with maximum values near 650 cal. cm. (-2) day (-1). Net radiation averaged approximately 70% of the Eppley values. Standard pan evaporation was 0.5 to 0.6 cm. day (-1) with maximum values near 1.0 cm. day (-1). Evapotranspiration rates for grain sorghum grown in weighing lysimeters were generally 0.3 to 0.6 cm. day (-1) with peak values of 1.0 cm. day (-1). Rates calculated from a water budget as determined from water content measurements were in general agreement with lysimeter values.  
W69-03198

**2E. Streamflow and Runoff**

**HYDROLOGIC FORECASTS, PREDICTION PERIODS, RELIABILITY AND EXPERIENCE USING THEM IN WATER RESOURCES SYSTEMS,**  
For primary bibliographic entry see Field 06A.  
For abstract, see .  
W69-02802

**LOW STREAMFLOW IN THE MYAKKA RIVER BASIN AREA IN FLORIDA,**  
Geological Survey, Tallahassee, Fla.  
H. N. Flippo, Jr., and B. F. Joyner.  
Florida Board of Conserv., Rep of Invest No 53, 34 p, 1968. 5 fig, 6 tab, 11 ref.

Descriptors: \*Streamflow, \*Low flow, \*Base flow, \*Droughts, \*Florida, Hydrogeology, Stream gages, Duration curves, Water quality, Water utilization.  
Identifiers: \*Myakka River (Florida).

Streamflow data, collected in the Myakka River basin area since 1936 and supplemented by means of a more complete network of stream-gaging stations since 1963, indicate that all non-tidal reaches of streams in the area ceased natural flows during at least five droughts since 1938. Many of these non-tidal reaches go virtually dry during the late spring of most years. Effective utilization of streamflow is restricted by these frequent droughts and a limited choice of practicable storage sites. Upper and Lower Myakka Lakes, through which the Myakka River flows, occupy two of the largest natural depressions in the area and have a total storage capacity of approximately 8,100 acre-feet. Average discharge at a stream-gaging station located between these lakes is 266 cfs or about 192,000 acre-feet per year. Draft-storage studies indicate that these lakes will provide a continuous draft of at least 6.5 mgd, provided their storage potential is adequately developed. Surface waters that are derived from natural drainage are of good quality, except for occasional high color and temperatures of about 90 deg F during the summer months. In many channels in low lying areas, low flows are often supplemented by waters of relatively high dissolved solids content derived from irrigation wells and domestic waste.  
W69-02808

**THE TEMPORAL AND SPATIAL DISTRIBUTION OF DISSOLVED OXYGEN IN STREAMS,**  
Manhattan Coll., Bronx, N. Y.  
For primary bibliographic entry see Field 05A.  
For abstract, see .  
W69-02809

**DERIVATION OF BASIN HYDROGRAPHS,**  
Kansas Water Resources Research Inst., Manhattan.  
Robert L. Smith, and Alan M. Lumb.  
Kans Water Resources Res Inst, Proj Completion Rep, 28 p, 1966. 8 fig, 16 ref, 2 append. OWRR Proj A-003 Kan.

## Field 02—WATER CYCLE

### Group 2E—Streamflow and Runoff

Descriptors: \*Rainfall-runoff relationships, \*Mathematical models, \*Hydrographs, Kansas, Hydrologic budget, Evapotranspiration, Groundwater movement, Routing, Storage, Soil water movement, Digital computers, Computer models, Computer programs.

Identifiers: Thiessen polygon.

A mathematical model of the land phase of the hydrologic cycle is being developed with special attention directed toward the nature and extent of available data in Kansas. Areal non-uniformity of rainfall is handled by subdividing the basin with a Thiessen polygon. Daily accounting is used whenever daily precipitation is less than 0.1 in.; for greater amounts hourly accounting is utilized. Subsurface zones include an upper and lower soil zone plus a groundwater zone. The latter is limited to the alluvial portion of the basin. Sub-surface drainage elsewhere in the basin is treated as interflow in response to geologic and topographic considerations. Evapotranspiration calculations utilize a potential rate based on mean daily temperature and discounted for moisture availability and depth. Hydrograph development in the initial model was based on a daily distribution graph. A lag and route procedure involving the use of distributed storage within the basin is being developed. Initial test results were satisfactory and continued development and testing is underway. A Fortran listing of the model is included.

W69-02811

#### LOW-FLOW AND BASIN CHARACTERISTICS OF TWO STREAMS IN NORTHERN VERMONT,

Agricultural Research Service, Danville, Vt. Soil and Water Conservation Research Div.

For primary bibliographic entry see Field 02A.

W69-02814

#### CARACTERIZAREA HIDROLOGICA A ANULUI 1966 (HYDROLOGICAL CHARACTERIZATION OF 1966),

Dumitru Lazarescu.

Hidrotehnica, Gospodarirea Apelor, Meteorologia, (Bucharest), Vol 12, No 7, p 351-55, 1967. 3 figs, 2 tables, 6 ref.

Descriptors: \*Hydrologic cycle, \*Streamflow, Water levels, Histograms, Average flow, Volume, Freezing, Melt water.

Identifiers: \*Romania, \*Freezing waterways.

Hydrological conditions during 1966 in Rumania are compared with tabulated data from previous years. In general, the year was characterized by ample water supplies from March-May and lower levels from September-November. A high stage was noted in February. Maximum and minimum values of average annual flow, measured at various hydrological stations, are provided for thirty streams in Rumania. Histograms show values for average annual flow throughout the year. The monthly distribution of stream velocity and volume is tabulated for 12 rivers, and line graphs are presented to show monthly variations. The phenomena of freezing waterways was registered in January and February, but only in the Siret and Somes basins in December. This suggests that the melting ice accounted for higher water levels in February. Downstream on the Dunare River, floating ice was observed for several days. (Llaverias-USGS)

W69-02815

#### FLOODS IN WAIMANALO AREA, OAHU, HAWAII,

Geological Survey, Washington, D. C.

Reuben Lee, and William C. F. Chang.

U S Geol Surv, Hydrol Invest Atlas HA-314, 1 sheet, 1968. Text, 6 fig, 6 ref.

Descriptors: \*Floods, \*Hawaii, Discharge (Water), Stage-discharge relations, Streamflow, Flow measurement.

Identifiers: \*Waimanalo (Oahu-Hawaii), Discharge-frequency, Stage-frequency, Flood data, Flooded area.

Hydrologic data on flooding in the Waimanalo area, Oahu, Hawaii, are presented in a 1-sheet Hydrological Atlas. The approximate areas inundated by the floods of November 12-14, 1965 are delineated on a topographic map scaled 1:12,000. Graphs show floods greater than 1,200 cfs, discharge-frequency relations, and stage-frequency relations. Recurrence intervals are tabulated. (Knapp-USGS)  
W69-02818

#### WATER RESOURCES RESEARCH: ASPECTS OF A REGIONAL STUDY IN THE HUNTER VALLEY, NEW SOUTH WALES,

Monash Univ., Clayton (Australia).

T. A. McMahon.

J Hydrol, Vol 7, (1969), No 1, pp 14-38, Nov 1968.

25 p, 13 fig, 2 tab, 43 ref.

Descriptors: \*Water resources, \*Regional analysis, \*Hydrologic data, Climatic data, Low flow, Base flow, Recession curves, Hydrographs, Storage, Streamflow, Water yield, Gaging stations, Duration curves.

Identifiers: \*New South Wales (Australia), Hunter Valley (NSW), Flow duration.

The methods used within a regional analytical framework to survey and interpret the yield and low-flow characteristics of streams in the Hunter Valley, New South Wales are described. These methods may be grouped under three heads: the study of unregulated streams (yield, flow duration and low flow frequency analyses), the study of regulated streams (storage-draft analyses) and regional extrapolation procedures. For those particular techniques examined where the approach is not generally well known, the relevant literature is reviewed, the methodology is discussed and the general procedure for interpretation of the analysis is set down. Pertinent examples using Hunter Valley data are included.  
W69-02819

#### FLOOD OF AUGUST 1966 AT CARLSBAD, NEW MEXICO,

Geological Survey, Washington, D. C.

L. P. Denis.

U S Geol Surv Hydrol Invest Atlas HA-318, 1 sheet, 1968. Text, 3 fig.

Descriptors: \*Floods, \*New Mexico, Discharge (Water), Stage-discharge relations, Streamflow, Flow measurement.

Identifiers: \*Carlsbad (New Mexico), Discharge-frequency, Stage-frequency, Flood data, Flooded area.

The extent of flooding on August 23, 1966, at Carlsbad, New Mexico, is described in a 1-sheet Hydrological Atlas. The inundated area is delineated on a city street map scaled about 1,000 ft per in. Graphs show annual floods above 3,090 ft elevation, discharge-frequency relations, and the profile of the August 23, 1966 flood. Recurrence interval and stage data of historic floods are tabulated. (Knapp-USGS)  
W69-02820

#### TRACER MEASUREMENT OF STREAM REAERATION. II. FIELD STUDIES,

Georgia Inst. of Tech., Atlanta; Arctic Health Research Center, Fairbanks, Alaska; and Southwestern Radiological Health Lab., Las Vegas, Nev.

E. C. Tsivoglou, J. B. Cohen, and S. D. Shearer.

J Water Pollut Contr Federation, Vol 40, No 2, Part 1, pp 285-305, Feb 1968. 21 p, 3 fig, 6 tab, 10 ref.

Descriptors: \*Reaeration, \*Surface waters, \*Instrumentation, \*Tracers, \*Radioisotopes, Tritium, Dye releases, Dissolved oxygen, Dispersion, Diffusion.

Identifiers: Krypton.

A tracer method for accurate and independent measurement of the gas transfer and reaeration capacity of natural streams is presented. Instantaneous point dosing of 3 tracers—a fluorescent dye (rhodamine-WT), a dispersion indicator (tritium), and a gaseous tracer (krypton-85) is used. The dye gives information on flow time and longitudinal dispersion and indicates when to sample the other 2 tracers. Tritium is not lost from the flow, and provides an accurate dispersion measure. Krypton-85 disperses like tritium and also is lost to the atmosphere by gas transfer. Comparison of krypton and tritium accurately evaluates the reaeration rate for krypton. The relationship between the reaeration rates of Kr and O is well known. The method was checked in the laboratory and in the Jackson River of Virginia and West Virginia. (Knapp-USGS)  
W69-02821

#### WATER RESOURCES OF THE MUSTINKA AND BOIS DE SIOUX RIVERS WATERSHED WEST-CENTRAL MINNESOTA,

Geological Survey, Washington, D. C.

For primary bibliographic entry see Field 02F.

For abstract, see .

W69-02829

#### URBANIZATION AND ITS EFFECT ON THE TEMPERATURE OF LONG ISLAND STREAMS,

Geological Survey, Washington, D. C.

For primary bibliographic entry see Field 05A.

For abstract, see .

W69-02830

#### THE INITIAL PHASE OF THE RISING HYDROGRAPH OF TURBULENT FREE SURFACE FLOW WITH UNSTEADY LATERAL INFLOW,

Cornell Univ., Ithaca, N. Y.

Wilfried Brutsaert.

Water Resources Res, Vol 4, No 6, pp 1189-1192,

December 1968. 4 p, 7 ref.

Descriptors: \*Overland flow, \*Unsteady flow, \*Open channel flow, Mathematical studies, Chezy equation, Continuity equation, Mannings equation.

Identifiers: \*Kinematic wave theory, St. Venant equations.

An exact solution is obtained for the de Saint Venant equations describing flow over a plane or in a very wide channel with a general turbulent friction law and with a uniform lateral inflow as a power function of time valid for the space-time domain bounded by  $x$  between 0 and  $L$ ,  $t = 0$ , by the forward characteristic originating at  $x = 0$ ,  $t = 0$ , and by the backward characteristic originating at  $x = L$ ,  $t = 0$ . The quantity  $L$  denotes the length of the flow region,  $x$  the direction of flow, and  $t$  the time. It was found that, for very small values of time, the uniform flow velocity is everywhere directly proportional to  $t$  regardless of the nature of the lateral inflow. For a very large slope or a large roughness of the plane, or for a very small constant lateral inflow, the present solution reduces to the result obtainable with the kinematic wave approximation.  
W69-02837

#### FLOODS ON CHENANGO RIVER AND CANASAWACTA CREEK AT NORWICH, NEW YORK,

Geological Survey, Washington, D. C.

Stephen Hladio.

U S Geol Surv Hydrol Invest Atlas HA-297, 1 sheet, 1968. Text, 4 fig, 1 map.

Descriptors: \*Floods, \*New York, Stage-discharge relations, Ice jams, Discharge (Water), Profiles, Flood protection.

Identifiers: \*Chenango River Basin (NY), \*Flood profiles, Recurrence intervals, Inundation.

Hydrologic data pertaining to the extent, depth, and frequency of flooding that may be expected

## Streamflow and Runoff—Group 2E

along Chenango River and Canasawacta Creek near Norwich, New York, are presented in a 1-sheet hydrological Atlas report. A map, scaled 1:12,000 shows topography and areas inundated by floods with recurrence intervals of 5, 25, and 50 years and one ice jam flood on Canasawacta Creek. Figures show annual flood heights above 1046.2 ft on the Chenango River, above 1082.6 feet on Canasawacta Creek, flood profiles on Chenango River and Canasawacta Creek, and stage-frequency relations of floods. (Knapp-USGS) W69-02839

## EVALUATION OF ZINGG CONSERVATION BENCH TERRACES ON AMARILLO FINE SANDY LOAM SOIL.

Agricultural Research Service, Big Spring, Tex.; and Agricultural Research Service, Chichasha, Okla.

D. V. Armburst, and N. H. Welch.

J Soil and Water Conserv, Vol 21, No 6, pp 224-226, Nov-Dec 1966. 3 p, 3 fig, 3 tab.

Descriptors: \*Soil conservation, Water conservation, \*Erosion control, \*Terracing, \*Surface runoff, Infiltration, \*Rainfall intensity, \*Loam, Moisture content, Bench leveling, Soil moisture, Crop response, Sands, Fine-textured soils, Storage capacity.

The Zingg terrace system was designed to control water erosion and conserve and distribute runoff water. The conservation bench terraces were constructed on Amarillo fine sandy loam soil at Big Spring, Texas. The bench terraces increased crop yields only 1 year in 4—an insignificant increase. The failure can be partially explained by the soil. The soil had a high intake rate and a small soil moisture storage capacity; about 4 inches of available water in the top 4 feet of soil. Runoff was limited to large rains, high-intensity rains, or rains that followed a previous rain within a day or two. Amount and distribution of rainfall may also partially explain the failure of the terraces to produce higher crop yields. Bench terraces could possibly be used in arid climates to conserve and distribute runoff water. (Blecker-Arizona)

W69-02971

## FLOOD PLAIN INFORMATION, HARPETH RIVER, FRANKLIN, TENNESSEE.

Corps of Engineers, Nashville, Tenn.

U S Army Corps of Eng, Nashville Dist, Nashville, Tenn Rep, 37 p, July 1968. 8 fig, 11 plate, 7 tab.

Descriptors: \*Floods, \*Tennessee, \*Flood damage, \*Flood protection, Non-structural alternatives, Flood plain zoning, Floodproofing. Identifiers: Franklin (Tenn), Harpeth River (Tenn).

Flooding of the Harpeth River in Franklin, Tenn. is described to aid in the solution of local flood problems and in planning land use for the area subject to flooding. Records of the largest known past floods are listed. Probable future floods are calculated. Maps, profiles, and cross sections show the extent of flooding in the past and what might take place in the future. Most of Franklin is on high ground west of the river but some residential and commercial development is on the flood plain. Flood plain zoning for parks and other uses that are not damaged by flooding is recommended. Corrective measures for present developments include floodproofing by closing lower openings of buildings, waterproofing walls and floors, installing removable bulkheads over doors, and other structural changes. (Knapp-USGS) W69-03041

## UNSTEADY FLOW IN OPEN CHANNELS,

Belgrade Univ. (Yugoslavia).

Dragutin Muskatirovic.

Translation from Proc Institut za Paljoprivrednu 'Jaroslav Cerni' Vol 14, No 41-42, pp 49-54, 1967.

TT67-58016.

Descriptors: \*Unsteady flow, \*Open channel flow, \*Mathematical models, Digital computers, Dam failure, Routing, Streamflow forecasting. Identifiers: St. Venant equations, Finite differences methods, Method of characteristics.

The hydraulic regime, usually involving unsteady flow, in natural and artificial open channels is studied and a general mathematical model for its solution is proposed. The general cases considered are flood wave transformation and propagation in natural watercourses, influence of reservoirs on water levels and discharges both up and downstream, analytical and model study of the hydraulic consequences of dam breaking, and the development of calculation methods and procedures to simplify calculations in routine practice, particularly by using computers. The mathematical model is based on St. Venant's equations. Solutions are obtained by the method of characteristics, finite difference methods, and empirical methods. Several practical solutions are presented for the cases discussed. Literature is cited for specific detailed discussion of each case. (Knapp-USGS) W69-03044

## HYDROLOGIC DATA: 1967 - VOLUME IV: SAN JOAQUIN VALLEY.

California Resources Agency. Dept. of Water Resources.

Calif Dep of Water Resources, Bull No 130-67, 321 p, 1968. 7 fig, 4 plate, 26 tab.

Descriptors: \*Data collections, \*Hydrologic data, \*California, Climates, Streamflow, Groundwater, Water levels, Water level fluctuations, Recharge, Water quality, Water wells.

Identifiers: \*San Joaquin Valley (California), Water level measurements, Periodic observations.

Annual hydrological data are compiled for the San Joaquin Valley, California, 1967. Tables show data on climate, surface water flow, ground water levels, ground water recharge, and surface and ground water quality in the San Joaquin Valley for the 1966-67 water year. Figures show location of climatological, surface water, and surface water quality measurement stations; fluctuation of water levels in selected wells and areas; and electrical conductance at selected stations. Plates show lines of equal elevation of water in wells in spring 1967, profile of ground water levels, cooperative study area, ground water level changes, and well locations. (Knapp-USGS) W69-03068

## ANALYTICALLY DERIVED UNIT GRAPH AND RUNOFF,

Tennessee Valley Authority, Knoxville.

For primary bibliographic entry see Field 02A.

For abstract, see .

W69-03069

## RUNOFF HYDROGRAPHS FOR MATHEMATICAL WATERSHED MODEL,

Minnesota Univ., St Paul. Dept. of Agricultural Engineering.

Roger E. Machmeier, and Curtis L. Larson.

ASCE Proc, J Hydraul Div, Vol 94, No Hy6, Pap 6248, pp 1453-1474, Nov 1968. 22 p, 7 fig, 5 tab, 22 ref.

Descriptors: \*Mathematical models, \*Unit hydrographs, \*Routing, Synthetic hydrology, Rainfall-runoff relationships, Digital computers, Computer programs, Watersheds (Basins).

Identifiers: Finite difference methods, Non-linear runoff-discharge relations.

A mathematical model of the channel system of a 21.35-sq mile watershed was developed. The partial-differential equations of momentum and continuity were expressed in finite difference form, and used to route the unsteady flow through the channel system, yielding outflow hydrographs.

Rainfall excess in various rates and durations was used as the input to the model. All the hydrologic time parameters evaluated from the model output varied with the supply rate. If the response of the watershed model can be considered representative of a natural watershed, none of the presently defined time parameters should be considered constants for a given watershed. The time to virtual (97% of) equilibrium varied inversely as the 0.23 power of the supply rate. The peak-flow rates showed a nonlinear relationship to runoff amount for a given duration. Peak discharges obtained with the model watershed do not support the unit-hydrograph principle but add to the existing evidence of runoff nonlinearity. (Knapp-USGS) W69-03070

## RADIATION AND SNOWMELT ON A CLEAR-CUT WATERSHED,

Northeastern Forest Experiment Station, Durham, N. H.

For primary bibliographic entry see Field 02C.

For abstract, see .

W69-03078

## FLOOD OF JUNE 7, 1967, IN THE WAPSINONOC CREEK BASIN, IOWA,

Geological Survey, Iowa City, Iowa.

Harlan H. Schwob.

U S Geol Surv open-file rep, Jan 1968. 16 p, 3 fig, 1 tab, 1 ref, 1 append.

Descriptors: \*Floods, \*Iowa, \*Data collections, \*Small watersheds, Discharge (Water), Stage-discharge relations, Hydrographs, Stream gages, Historic flood, Rain.

Identifiers: Wapsinonoc Creek (Iowa), Flood data, 50-year flood.

An outstanding flood occurred in the Wapsinonoc Creek basin in east-central Iowa on June 7, 1967. The flood was the result of rainfall totaling from 4 to 13 in. in about 14 hours on the night of June 6 and the morning of June 7. The storm was nearly centered over the 180-sq-mi basin. The resulting peak discharges ranged from about 1.9 to about 4.3 times the 50-yr recurrence interval flood. A peak discharge of 27,400 cu ft per second was measured from 161 square miles of the basin. This and other peak discharges for drainage areas larger than 40 sq mi were among the greatest recorded in the last 50 yr in eastern Iowa. Flood damage was light because the basin is used primarily for agriculture and the crops were in their early growth stage. There was no loss of human life attributed to the flood. W69-03085

## STATISTICAL TESTS FOR COMMON BANKFULL FREQUENCY IN RIVERS,

New South Wales Univ., Kensington (Australia). Dept. of Statistics; and Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Land Research.

C. A. McGilchrist, and K. D. Woodyer.

Water Resources Res, Vol 4, No 2, pp 331-334, April 1968. 4 p, 2 tab, 6 ref.

Descriptors: \*Frequency analysis, \*Floods, Statistics, Flood plains, Rivers, Geomorphology, Streamflow, Channel morphology.

Identifiers: \*Bankfull frequency, Australia (New South Wales).

Two statistical tests are described for investigating the claim that rivers exceed bankfull level with a common frequency. The first test is necessary to demonstrate that vertically adjacent bench level categories at a site are separate in terms of expected recurrence intervals. The second test examines the homogeneity of bankfull frequencies from site to site for each bench level category. The tests were used to examine data from nine stream gaging sites in New South Wales, Australia. It was shown that three distinct bench levels could be identified in the field. The bankfull frequencies as-

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sociated with the present flood-plain level were shown to form a homogeneous population of bankfull frequencies.  
W69-03096

**REVIEW AND ANALYSIS OF RAINFALL AND RUNOFF DATA FOR SELECTED WATERSHEDS IN MINNESOTA,**  
Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.  
For primary bibliographic entry see Field 02A.  
For abstract, see .  
W69-03098

#### METHODS OF FLOW FREQUENCY ANALYSIS,

Inter-Agency Committee on Water Resources, Washington, D. C. Subcommittee on Hydrology. W. D. Potter, Manuel A. Benson, and Charles B. Pletcher.

Subcommittee on Hydrol, Inter-Agency Comm on Water Resources Bull No 13, April 1966. 41 p, 15 fig, 8 tab, 34 ref.

Descriptors: \*Frequency analysis, \*Statistical methods, \*Mathematical studies, Methodology, Hydrologic aspects, Analytical techniques, Streamflow, Stream gages, Design.

Identifiers: \*Flow frequency methods, Extension of records.

Flow frequency methods now most commonly used by Federal agencies are described. The history of the development of frequency methods, including the adoption of statistical methods to frequency analysis is also discussed. The five methods of frequency analysis, which are Hazen, Pearson type III, Gumbel, Gamma distribution, and Graphical distribution-free, have much in common. Experience rather than theory has been the factor in the development of the various methods. References in which these methods are discussed in great detail and a glossary of terms used in frequency analysis are appended. (Steinhilber-USGS)  
W69-03102

#### THE HYDRAULICS OF OVERLAND FLOW ON HILLSLOPES,

Geological Survey, Washington, D. C. Water Resources Div. William W. Emmett.

U S Geol Surv open-file rep, 205 p, 1968. 42 fig, 7 tab, 42 ref, 6 append.

Descriptors: \*Overland flow, \*Rainfall-runoff relationships, \*Model studies, Statistical models, Hydraulic models, Sheet erosion, Laminar flow, Turbulent flow, Sheet flow, Darcy-Weisbach equation.

Identifiers: \*Hillslope hydraulics.

Field and laboratory studies were made of the rainfall-overland flow relationship by sprinkling water at a known rate on an indoor flume and on natural hillslopes. Overland flow increases downslope in depth and velocity; depth accounts for about 2/3 and velocity, 1/3 of the flow increase. Flow resistance is nearly constant in the downslope direction. Field and laboratory results agree well, but illustrate the great influence of vegetation and topography on flow resistance. Flow occurred principally in anastomosing downhill paths. The flow regime was not truly laminar because of the influence of falling raindrops and land surface irregularities. Surface erosion was observed but no rilling developed. A statistical model of overland flow was developed and showed that the slope for laminar flow increases downslope, the slope for turbulent flow decreases, and for mixed flow, the slope may be constant. Thus, hillslopes that fit the model must have convex tops, straight middles, and concave bottoms, as usually found in nature. (Knapp-USGS)  
W69-03110

**FLOOD RUNOFF FROM PARTIALLY URBANIZED AREAS, WICHITA, KANSAS,**  
Geological Survey, Lawrence, Kans.; and Wichita and Sedgwick County Flood Control Office, Wichita, Kans. I. C. James.

U S Geol Survey open-file rep, June 1967. 62 p, 21 fig, 10 tab, 13 ref.

Descriptors: \*Urbanization, \*Storm runoff, \*Small watersheds, Kansas, Peak discharge, Floods, Hydrologic data, Stream gages.

Identifiers: Wichita (Kansas), Unit hydrographs.

The effect of changes in urbanization on flood runoff near Wichita, Kansas was studied from rainfall, runoff, and urbanization records. Data for the first 3 years of operation of the project include the degree of urbanization as of September 1964, the maximum flood hydrographs and associated rainfall experienced during the 3 years, and the developed unit hydrographs of six study basins. The types of urbanization are presented in tabular form, categorized according to land usage or coverage, and show that imperviousness varies from 0.86 percent to 30.48 percent in the six study basins. Variations between unit hydrographs developed from individual storms are probably caused by nonuniform rainfall excess. Urbanization may quite significantly affect flood peaks. For instance, fully urbanized Dry Creek, with a drainage area of 2.94 sq. mi. of which 30.48 percent is impervious, exhibited a unit hydrograph peak nearly the same as West Branch Chisholm Creek, with a drainage area of 16.10 sq. mi. and an imperviousness of 1.85 percent, although with the effect of drainage area and slope taken into consideration, the unit peak on West Branch Chisholm Creek should be 2 to 2 1/2 times that of Dry Creek.  
W69-03118

## 2F. Groundwater

#### LOW STREAMFLOW IN THE MYAKKA RIVER BASIN AREA IN FLORIDA,

Geological Survey, Tallahassee, Fla. For primary bibliographic entry see Field 02E.

For abstract, see .

W69-02808

#### MISCIBLE DISPLACEMENT IN AN UNSATURATED GLASS BEAD MEDIUM,

Guelph Univ., (Ontario).

For primary bibliographic entry see Field 02G.

For abstract, see .

W69-02810

#### PERMEABILITY OF ORTHOTROPIC POROUS MEDIUMS,

State Univ. of New York, Buffalo.

Barna A. Szabo.

Water Resources Res, Vol 4, No 4, pp 801-808, Aug 1968. 8 p, 4 fig, 1 tab, 13 ref.

Descriptors: \*Porous media, \*Mohr circle, \*Permeability, Darcys law, Groundwater, Hydraulics, Mathematical studies.

Identifiers: Transformation law, Orthotropic, Porous mediums.

A mathematical definition of permeability is developed from the assumption that orthotropic porous medium obey Darcy's Law in the three directions normal to the structural planes of symmetry of the medium. This assumption leads to the conclusion that permeability obeys the transformation law definitive of second-order tensors; and that consequently a permeability quadric (the Mohr circle representation of transformation of permeability components and permeability invariants) can be defined. It was concluded that permeability, because of its transformation properties, is analogous to these conceptually unrelated physical objects. This analogy permitted the application of the Mohr circle to represent the transformation of permeability components in any principal plane. (Llaverias-USGS)

W69-02812

**GROUND-WATER WITHDRAWAL IN THE ODESSA AREA, ADAMS, GRANT, AND LINCOLN COUNTIES, WASHINGTON,**  
Washington State Dept. of Water Resources.

A. A. Garrett.

Wash State Dep of Water Resources Water-Supply Bull No 31, 84 p, 1968. 8 fig, 1 plate, 4 tab, 4 ref.

Descriptors: \*Groundwater, \*Water utilization, \*Irrigation, \*Water level fluctuations, \*Washington, Data collections, Water wells, Water levels, Hydrographs.

Identifiers: Odessa area (Washington), Adams County, Grant County, Lincoln County.

The withdrawal and use of groundwater for irrigation near Odessa, Washington, was studied by the state of Washington in cooperation with the U. S. Geological Survey. Before 1960, groundwater was used only for public supply and for individual farmsteads. Since 1960, irrigation of wheat with groundwater has become common and withdrawals have greatly increased. In 1963, 66 irrigation wells pumped a total of about 11,400 acre-feet of water. In 1965, 94 wells pumped about 22,000 acre-feet. More irrigation wells are being drilled and still others are planned in the near future. Groundwater supplies are being developed nonuniformly within the project area and, as a result, groundwater levels are declining as much as 20 ft in some areas. Most wells in the area are pumped nearly continuously during 7 months of the year and are idle during the other 5. In many parts of the project area, water levels in shallow aquifers are different in altitude from those in the deeper aquifers tapped by many large-yield irrigation wells, but pumping of some of the deeper irrigation wells has resulted in declines of water levels in some shallow wells. Simultaneous pumping of several wells has resulted in declines of as much as a foot in shallow wells as far as 3 miles distant. (Knapp-USGS)  
W69-02823

**VIRUS MOVEMENT IN GROUNDWATER,**  
Arkansas Univ., Fayetteville; and Stanford Univ., Calif.

For primary bibliographic entry see Field 05B.

For abstract, see .

W69-02824

**GROUNDWATER FLOW SYSTEMS IN THE CRYSTALLINE ROCKS OF THE OKANAGAN HIGHLAND, BRITISH COLUMBIA,**  
Department of Energy, Mines and Resources, Ottawa (Ontario). Inland Waters Branch.

D. W. Lawson.

Can J of Earth Sci, Vol 5, pp 813-823, 1968. 11 p, 7 fig, 3 tab, 19 ref.

Descriptors: \*Aquifers, \*Groundwater movement, \*Crystalline rocks, \*Mountains, \*Valleys, Glaciation, Piezometers, Water table, Fractures (Geology), Hydraulic conductivity, Transmissivity.

Identifiers: Okanagan Highland (British Columbia), Glacial valleys, Flow systems.

An investigation, using a line of piezometers ranging in depth from 25 to 102 ft, of the relation between groundwater flow systems and topography in the Okanagan Highland revealed that the hydraulic conductivity of the crystalline rock varies exponentially with depth. Local flow systems in the upper 150 ft conduct an estimated 10-17 imperial gpd per ft thickness in a 2-dimensional flow system. These shallow flow systems are the most important aquifers in the Okanagan Highland. (Knapp-USGS)  
W69-02826

**SPECIFIC YIELD-COMPILATION OF SPECIFIC YIELDS FOR VARIOUS MATERIALS,**  
Geological Survey, Washington, D. C. A. I. Johnson.

U S Geol Surv Water-Supply Pap 1662-D, 74 p, 1967. 19 fig, 29 tab, 65 ref.

**Descriptors:** \*Data collection, \*Specific yield, \*Earth materials, Laboratory tests, On-site tests, Hydrologic properties, Specific retention, Particle size, Porous media, Laboratory tests.  
**Identifiers:** Groundwater storage, Water-bearing sediments, Graphics.

Specific yield is defined as the ratio of the volume of water that a saturated rock or soil will yield by gravity to the total volume of the rock or soil, usually expressed as a percentage. The value is not definitive, because the quantity of water that will drain by gravity depends on variables such as duration of drainage, temperature, mineral composition of the water, and various physical characteristics of the rock or soil under consideration. Values of specific yield, nevertheless, offer a convenient means by which hydrologists can estimate the water-yielding capacities of earth materials and, as such, are very useful in hydrologic studies. Direct or modified quotations from many selected reports that evaluate methods for determining specific yield, limitations of those methods, and results of the determinations made on a wide variety of rock and soil materials are compiled. Although no particular values are recommended, a table summarizes values of specific yield, and their averages, determined for 10 rock textures. (Knapp-USGS)  
W69-02833

**WATER RESOURCES OF THE MUSTINKA AND BOIS DE SIOUX RIVERS WATERSHED WEST-CENTRAL MINNESOTA,**  
 Geological Survey, Washington, D. C.  
 R. W. Maclay, T. C. Winter, and L. E. Bidwell.  
 U S Geol Surv Hydrol Invest Atlas HA-272, 4 sheet, 1968, 4 ref.

**Descriptors:** \*Water resources, \*Groundwater, \*Surface waters, \*Hydrologic data, \*Minnesota, Streamflow, Water wells, Water quality, Water levels, Water yield, Hydrogeology.  
**Identifiers:** Mustinka River (Minn), Bois de Sioux River.

The water resources of the Mustinka and Bois de Sioux Rivers Watershed, West-Central Minnesota, were investigated and the results are presented in a 4-sheet Hydrological Atlas. The annual runoff of the area is about 1/2 inch, and ranges from 1/4 inch to nearly 3 inches. All municipal supplies are from groundwater sources. Streamflow is intermittent, with frequent flooding because of flat land surface, channels of low capacity, and low channel gradient. Most recharge is in a morainal area and groundwater moves through glacial drift to discharge in lowlands near lakes and rivers. Most wells are in the glacial drift. Only a few are drilled into the underlying Cretaceous sediments. Water in the drift is very hard, while water from the Cretaceous rocks is generally softer. Iron content of all groundwater is greater than 0.3 ppm. Water from the drift is suitable for irrigation where adequate drainage is provided, but water from the Cretaceous rocks has excessive Na content. Data on climate, water yield, surface water discharge, floods, groundwater occurrence, groundwater yield, and groundwater quality, are summarized in maps, graphs, and tables. (Knapp-USGS)  
W69-02829

**THE PERCHED WATER TABLE IN THE UPPER LIMESTONE AQUIFER OF MALTA,**  
 Institution of Water Engineers, London (England).  
 J. Newbery.  
*J Inst Water Eng*, Vol 22, No 8, pp 551-570, Nov 1968. 20 p, 8 fig, 3 tab, 4 ref.

**Descriptors:** \*Water resources, \*Groundwater, \*Aquifers, \*Perched water, Aquiclude, Limestones, Coral, Water yield, Permeability, Porosity, Specific yield, Saline water intrusion.  
**Identifiers:** \*Malta.

The groundwater resources of Malta were investigated with particular attention to the upper of 2 limestone aquifers separated by a clay aquiclude. In the lower limestone the water table is controlled by sea level, and in the upper aquifer, the Upper Coralline Limestone, the water table is perched. The lower aquifer is overpumped and salinity is increasing, so hydrogeological study of the upper aquifer was carried out to develop more water supplies. A survey was made using data from over 1,500 boreholes to determine geologic structure, permeability, and specific yield. The upper aquifer is as much as 335 ft thick, faulted into many small grabens and ridges, and has a large number of sinkholes. Permeability, measured in cores and in pumping tests, varies from almost nil to .00071 cm per sec. Potential total water yield is estimated to be 2,000 million gallons per year from a system of intercepting galleries and boreholes. The cost of groundwater development is about the same as that of developing and using sea water distillation. (Knapp-USGS)  
W69-02833

**HYDROGEOLOGY OF DESERT BASINS,**  
 Nevada Univ., Reno.  
 George B. Maxey.  
*Ground Water*, Vol 6, No 5, pp 10-22, Sept/Oct 1968. 13 p, 16 fig, 29 ref.

**Descriptors:** \*Hydrogeology, \*Deserts, \*Arid lands, Hydrology, Nevada, \*Groundwater, Surface waters, Water analysis, Optimum development plans, Drawdown, Aquifers, Bibliographies, Groundwater flow, Water quality, \*Groundwater geology, Groundwater mining, Groundwater recharge.  
**Identifiers:** Groundwater sources, Groundwater management.

Hydrologic systems in arid lands normally include a recharge area in mountains and a discharge area in lowlands, often with an intermediate area of lateral flow between recharge and discharge areas. This system is often modified by local geologic, climatic, and physiographic factors. Most water supply, contamination, and disposal problems arise from a combination of features superimposed on this system by concentration of population and agricultural activity in discharge areas. Data on this system come from the lowlands; little data are available from recharge areas. In the Great Basin, 2 general categories of groundwater flow systems are identified and their characteristics described. Although most flow systems in Nevada have not been delineated, integration of hydrologic, geologic, and chemical methods allows approximate portrayal of many local and regional systems. Adequate methods on which to base planning for optimum development of water resources in desert basins are available. A conceptual model of optimal ground-water reservoir development illustrates optimum use of storage and perennial yield, provided the use and time of withdrawal of the water are known. (USBR)  
W69-02924

**RADIUS OF INFLUENCE OF A WELL,**  
 Mladen Boreli.  
*Saopstenja*, Vol 14, No 43, pp 13-23, 1967. 11 p, 3 fig, 1 tab, 4 ref.

**Descriptors:** Groundwater, \*Groundwater flow, Discharges, \*Groundwater recharge, \*Wells, Aquifers, \*Water yield, Water table, Pumping, Artesian water, Foreign design practices, Reviews, Infiltration, Drawdown, \*Water wells, Recharge.  
**Identifiers:** Dupuit formula, Yugoslavia, Leaky aquifers, Well yield.

The radius of influence of a well is a representative indicator of the ground-water balance and is defined by ground-water recharging conditions. By determining the radius of influence in the field, information may be derived on the local water balance and recharge of water pumped out. The original definition for the radius of influence lacks

sufficient precision for estimating well discharge under conditions of intensive ground-water pumping; a more rigorous definition is given, based on Dupuit's formula. Analytical expressions for various cases of horizontal and vertical recharge are summarized and several empirical formulas reviewed. Many formulas given in the literature are in error, are trivial, or give an illusion of accuracy when in fact they are only rough approximations. The radius of influence should be calculated only after analyzing the type of discharge according to given formulas. (USBR)  
W69-02946

**DETERMINING CONSUMPTIVE USE FOR PLANNING WATER DEVELOPMENTS,**  
 California Univ., Los Angeles; and Clyde-Criddle-Woodward, Inc., Salt Lake City, Utah.  
 For primary bibliographic entry see Field 021.  
 For abstract, see .  
 W69-02970

**ELECTRIC-ANALOG AND DIGITAL-COMPUTER MODEL ANALYSIS OF STREAM DEPLETION BY WELLS,**  
 Geological Survey, Denver, Colo.  
 C. T. Jenkins.  
*Groundwater*, Vol 6, No 6, pp 27-34, Nov-Dec 1968. 8 p, 6 fig, 3 tab.

**Descriptors:** Model studies, \*Analog computers, Analytical techniques, Aquifers, Computer models, \*Digital computers, \*Wells, Pumping, \*Withdrawal, \*Streamflow, Surface-groundwater relationships, Groundwater recharge, Maps, Recharge, Discharge (Water), Boundaries (Surface), Variability.  
**Identifiers:** Ratios, Curves.

Electric-analog or digital-computer models are used to compute the effect of groundwater withdrawal or recharge on streamflow. The relation between pumping time and volume of stream depletion at any location in the system can be determined from tests on the model. As useful as such data may be, separate model tests for every possible location and for every conceivable pattern of pumping would require an inordinate amount of time and money. The purposes of this report were to examine the errors that are introduced by generalizing the results of a relatively small number of tests, and to show an example of a map showing lines of potential equal effect on streamflow. The generalization was based on the similarity in shape of the relations between pumping time and stream depletion for (1) semi-infinite homogenous aquifers drained by a straight, fully penetrating stream, and (2) complex heterogeneous aquifers. (Affleck-Arizona)  
W69-02976

**APPLICATION OF THE GRAVITY SURVEY METHOD TO WATERSHED HYDROLOGY,**  
 Agricultural Research Service, Tucson, Arizona.  
 Southwest Watershed Research Center.  
 For primary bibliographic entry see Field 04D.  
 For abstract, see .  
 W69-02982

**HYDRO-GEOLOGY OF QUATERNARY FORMATION FROM RIVER LUNI AND ITS TRIBUTARIES CATCHMENT.**  
 Central Arid Zone Research Institute, Jodhpur (India).

P. C. Chatterji, R. K. Saxena, and M. L. Sharma.  
*Annals of Arid Zone*, Vol 7, No 1, pp 31-48, March 1968. 18 p, 2 fig, 9 tab.

**Descriptors:** \*Groundwater, \*Groundwater basins, \*Petrography, Salts, \*Quaternary period, Geomorphology, Aquifers, Alluvium, \*Hydrogeology, Sands, Surveys, Topography, Watersheds (Basins), Arid climates, Depth, Semiarid climates.  
**Identifiers:** \*Rajasthan (India), Water potential.

## Field 02—WATER CYCLE

### Group 2F—Groundwater

A hydro-geological survey was carried out in the arid and semi-arid zone of Rajasthan, India. Aerial photographs and 1:126720 scale topographical sheets were used to conduct the survey. Samples of groundwater were taken either from freshly dug wells or where the lithology of aquifers was exposed. The wells were studied for static water level, seasonal variation of static water level, and discharge potential. Taking the density of existing wells as the index of water potentiality of the lithological formation, younger alluvium stands first followed by older alluvium and blown sand. Water having total soluble salt contents up to 7000 ppm was associated equally with blown sand and younger alluvium while older alluvium had slightly higher salt contents. It was concluded that the younger alluvium was the more favorable formation for groundwater exploration in comparison to older alluvium and blown sand. (Affleck-Arizona) W69-02983

**THE EFFECT OF SILT-LADEN WATER ON INFILTRATION IN ALLUVIAL CHANNELS,**  
For primary bibliographic entry see Field 02J.  
For abstract, see .  
W69-02988

**GROWTH AND DECAY OF GROUNDWATER-MOUNDS IN RESPONSE TO UNIFORM PERCOLATION,**  
New Mexico Inst. of Mining and Technology,  
Socorro.  
Mahdi S. Hantush.  
Water Resources Res, Vol 3, No 1, pp 227-234,  
1967. 8 p, 1 fig, 1 tab, 14 ref.

Descriptors: \*Groundwater, \*Recharge, \*Water level fluctuations, Surface-groundwater relationships, Water spreading, Uniform flow, Groundwater movement.

Identifiers: Groundwater mounds, Circular recharge areas, Rectangular recharge areas.

The rise and decay of the water table in response to deep percolation depends on the shape of the recharging area, among other factors. Solutions describing this phenomenon when the recharging area is rectangular or circular in shape are developed for the case where the underlying aquifer is effectively infinite in areal extent. The solution when the recharging area is circular is given in terms of a function that can be easily tabulated for a practical range of the parameters. Approximate solutions in terms of already tabulated functions are presented also. The solution when the recharging area is rectangular is obtained in terms of a function that depends on two parameters. This function is tabulated for a wide range of the parameters. This tabulation, as well as approximate relations, affords a means for relatively simple calculation. The solutions are applicable if the rise of water table relative to the initial depth of saturation does not exceed 50%. (Knapp-USGS)  
W69-03048

**DRAWDOWN IN A WELL OF LARGE DIAMETER,**  
Geological Survey, Washington, D. C. Water Resources Div.  
Istavros S. Papadopoulos, and Hilton H. Cooper, Jr.

Water Resources Res, Vol 3, No 1, pp 241-244,  
1967. 4 p, 2 fig, 1 tab, 5 ref.

Descriptors: \*Groundwater, \*Drawdown, \*Transmissivity, \*Artesian wells, Discharge (Water), Permeability.

Identifiers: Large-diameter wells, Transmissivity calculations, Aquifer testing, Aquifer evaluation.

A large-diameter well drawdown solution which takes account of storage of water in the well bore is presented for the condition of constant rate discharge from a fully penetrated isotropic artesian aquifer. A set of type curves derived from this solution may be used to determine aquifer transmissibility by analysis of drawdown in the pumped well. (Knapp-USGS)

W69-03049

#### RESPONSE OF A FINITE-DIAMETER WELL TO AN INSTANTANEOUS CHARGE OF WATER,

Geological Survey, Washington, D. C. Water Resources Div.

Hilton H. Cooper, Jr., John D. Bredehoeft, and Istavros S. Papadopoulos.

Water Resources Res, Vol 3, No 1, pp 263-269,  
1967. 7 p, 6 fig, 3 tab, 7 ref.

Descriptors: \*Groundwater, \*Recharge, \*Injection, \*Transmissivity, Discharge (Water), Permeability.

Identifiers: Large-diameter wells, Transmissivity calculations, Injection tests, Well testing, Aquifer tests.

A solution is presented for the change in water level in a well of finite diameter after a known volume of water is suddenly injected or withdrawn. A set of type curves computed from this solution permits a determination of the transmissibility of the aquifer. (Knapp-USGS)  
W69-03057

#### STRATIFICATION OF FRESH AND SALT WATER ON BARRIER ISLANDS AS A RESULT OF DIFFERENCES IN SEDIMENT PERMEABILITY,

Geological Survey, Raleigh, N. C.

William H. Harris.

Water Resources Res, Vol 3, No 1, pp 89- 97,  
1967. 9 p, 5 fig, 2 tab, 8 ref.

Descriptors: \*Groundwater, \*Saline water-freshwater interfaces, \*Aquifers, \*Aquitards, \*Islands, Anisotropy, North Carolina, Saline water intrusion, Permeability.

Identifiers: Hatteras Island (N.C.).

Theoretical values are not valid for the relation of fresh-water head to the depth of the fresh-water-salt-water interface beneath barrier islands when there is substantial motion of fresh groundwater and where the sedimentary deposits are not homogeneous or isotropic. Where zones of fresh and salt water are stratified, fresh water occurs in zones of high permeability, whereas salty water occurs in zones of low permeability. Near Frisco, on Hatteras Island, North Carolina, the concentration of chloride in groundwater varies inversely with the relative permeability of the water-bearing zones to a depth of about 140 ft. Permeable zones generally contain water with a chloride content of less than 100 ppm, whereas relatively impermeable zones contain water with a chloride content greater than 100 ppm. The position of the contact of fresh water with salt water depends on the permeability of the sediments at depth and is affected by differential flushing by fresh groundwater as a result of the retreat of the sea water originally saturating the entire stratification, rather than by fresh-water head differences in the shallow aquifer system. (Knapp-USGS)  
W69-03058

#### EXPERIENCE IN BURIAL OF LIQUID RADIOACTIVE WASTES IN DEEP GEOLOGICAL FORMATIONS,

For primary bibliographic entry see Field 05E.

For abstract, see .

W69-03061

#### HYDROLOGIC EFFECTS OF PUMPING FROM THE FLORIDAN AQUIFER IN NORTHWEST HILLSBOROUGH, NORTHEAST PINELLAS, AND SOUTHWEST PASCO COUNTIES, FLORIDA,

Geological Survey, Tallahassee, Fla.

J. W. Stewart.

U S Geol Surv open-file rep, 241 p, 1968. 60 fig, 6 tab, 13 ref.

Descriptors: \*Water resources, \*Groundwater, \*Water level fluctuations, \*Florida, Water wells, Aquifers, Water quality, Water sources, Water yield, Specific capacity, Transmissivity, Storage coefficient.

Identifiers: Hillsborough County (Florida), Pinellas County (Florida), Pasco County (Florida), Tampa, Floridian aquifer.

The Floridan aquifer is the principal source of water supply for the rapidly growing Tampa area of Florida. It is limestone interbedded with dolomite, sand, and clay, becoming dolomitic at depth. Most producing wells are in the Suwannee Limestone in the upper part of the aquifer system. Sand, silt, and clay deposits from 35-75 ft thick overlie the aquifer and provide its principal source of local recharge. The transmissivity of the Floridan aquifer ranges from 165,000 to 550,000 gpd per ft, the coefficient of storage from 0.0005-0.0015, and the coefficient of leakage is about 0.00015 gpd per cu ft. Recharge is estimated to be 103 mgd, and 44.2 mgd was pumped in 1966, 97% for public supplies. Lowering of water levels from 1933-36 was about 9-13 ft in the Lutz field, 3-6 ft in the Cosmo field, and 2 ft or less in the Eldridge-Wilde field. Groundwater in the area is hard to moderately hard calcium bicarbonate type, acceptable for most uses except near the coast where the chloride content is high. The aquifer can supply more than the amount pumped, enough for foreseeable needs. Proper planning of well fields is needed for optimum development of aquifer. (Knapp-USGS)  
W69-03063

#### HYDROLOGIC DATA: 1967 - VOLUME IV: SAN JOAQUIN VALLEY.

California Resources Agency. Dept. of Water Resources.

For primary bibliographic entry see Field 02E.

For abstract, see .

W69-03068

#### GROUND-WATER OCCURRENCE AND STRATIGRAPHY OF UNCONSOLIDATED DEPOSITS, CENTRAL PIERCE COUNTY, WASHINGTON,

Department of Water Resources, Olympia, Wash.

Kenneth L. Walters, and Grant E. Kimmel.

Wash State Water Supply Bull No 22, 428 p, 1968. 19 fig, 3 plate, 9 tab, 34 ref.

Descriptors: \*Water resources, \*Groundwater, \*Washington, Water wells, Water quality, Water levels, Data collections, Hydrographs, Water yields, Water utilization.

Identifiers: Tacoma, Pierce County (Wash).

The groundwater resources of an area of 660 sq mi in west-central Washington, which includes the city of Tacoma and extends from Puget Sound to the foothills of the Cascade Range are described. The annual precipitation averages 38.5 in.; 85% occurs in September through April. Unconsolidated rocks, consisting of gravel, sand, silt, and clay of Miocene through Recent age, yield most of the water to wells in the county. The most important aquifers are the Quaternary unconsolidated deposits, particularly the Salmon Springs Drift, Vashon deposits, and Recent alluvium. Flowing wells are found in the Puyallup River valley and the Tacoma tidal flats. Public water supply uses 43,000 acre-ft of water and about 32,000 acre-ft are used for all other purposes. Withdrawal could be increased several times without serious depletion. The water is of good quality, satisfactory for most uses. In the uplands, water is primarily of the Ca bicarbonate type and in the Puyallup valley it is of the Na bicarbonate type. Locally seawater intrusion causes high chloride concentrations. Well records, driller's logs, and chemical analyses are tabulated. Maps show geology and location of wells and springs. (Knapp-USGS)  
W69-03081

## Water in Soils—Group 2G

**CARBON 14 AGES AND FLOW RATES OF WATER IN CARRIZO SAND, AT ATASCOSA COUNTY, TEXAS,**  
Geological Survey, Austin, Tex. Water Resources Div.  
F. J. Pearson, Jr., and D. E. White.  
Water Resources Res, Vol 3, No 1, pp 251-261, 1967. 11 p, 6 fig, 1 tab, 15 ref.

Descriptors: \*Groundwater movement, \*Flow rates, \*Radioactive dating, \*Carbon radioisotopes, Carbonates, Groundwater, Texas.

Identifiers: Carrizo Sand, Atascosa County (Texas).

The ages of water samples from the Eocene Carrizo Sand in Atascosa County and adjacent counties of Texas were determined by study of the carbon 14 content of the carbonate in the water. The carbon 14 is in plant-produced carbon dioxide in the soil of the recharge area. Dilution by carbon 14-free carbonate dissolved from the soil and aquifer can be corrected in the technique used. The ages of the samples ranged from 0 yr to outcrop to 27,000 yr 35 mi downdp. Water velocities are about 8 ft per yr 10 mi from outcrop. Flow rates calculated from available hydrologic data agree with the carbon 14 results. (Knapp-USGS)  
W69-03082

**SOME ASPECTS OF THE HYDROLOGY OF PONDS AND SMALL LAKES,**  
Minnesota Univ., St. Paul. Dept. of Agricultural Engineering.  
For primary bibliographic entry see Field 02H.  
For abstract, see .  
W69-03091

**WATER AND SEDIMENT IN THE NORRIS GLACIER OUTWASH AREA, UPPER TAKU INLET, SOUTHEASTERN ALASKA,**  
Alaska Univ., College. Inst. of Water Resources.  
For primary bibliographic entry see Field 02J.  
For abstract, see .  
W69-03093

**DEPLETION OF FLOW IN RIGHT-ANGLE STREAM BENDS BY STEADY WELLS,**  
New Mexico Tech., Socorro.  
For primary bibliographic entry see Field 02A.  
For abstract, see .  
W69-03094

**GROUNDWATER FAVORABILITY AREAS AND SURFICIAL GEOLOGY OF THE LOWER ANDROSCOGGIN RIVER BASIN, MAINE,**  
Geological Survey, Washington, D. C.  
Glenn C. Prescott, Jr.  
U S Geol Surv Hydrol Invest Atlas HA-285, 1 sheet, 1968. Text, 1 map, 4 ref.

Descriptors: \*Water resources, \*Water yield, Aquifers, Water quality, Geohydrologic units, Groundwater, Maine.

Identifiers: Androscoggin River basin (Maine).

Areas favorable for groundwater development in the lower Androscoggin River basin, Maine, are portrayed on a map and discussed in accompanying text. Ice-contact and outwash deposits, which are identified on the map, are the principal aquifers in the area. Wells tapping for former generally can obtain 50 gpm or more (occasional yields of 2,000 gpm are obtainable) of good-quality water; wells tapping the latter generally can obtain up to 50 gpm of good-quality water. Other unconsolidated materials and the bedrock in the lower basin generally do not yield over 10 gpm. The chemical quality of water, which is graphically depicted in the atlas, generally is good, except in areas of localized contamination. (Steinhilber-USGS)  
W69-03099

**SLOPE LENGTH OF CLAYPAN SOIL AFFECTS RUNOFF,**  
Agricultural Research Service, Columbia, Mo.; and Agricultural Research Service, Urbana, Ill.  
For primary bibliographic entry see Field 02A.  
For abstract, see .  
W69-03106

**HYDRAULIC AND MICROMORPHOLOGICAL PROPERTIES OF STREAM CHANNEL SEDIMENTS,**  
Arizona Univ., Tucson; and North Carolina State Univ., Raleigh.  
For primary bibliographic entry see Field 02J.  
For abstract, see .  
W69-03108

**FLOW OF GROUNDWATER ADJACENT TO SMALL, CLOSED BASINS IN GLACIAL TILL,**  
Idaho Univ., Moscow.  
R. E. Williams.  
Water Resources Res, Vol 4, No 4, pp 777-783, Aug 1968. 7 p, 4 fig, 2 tab, 6 ref.

Descriptors: \*Groundwater movement, \*Glacial drift, \*Till, Marshes, Basins, Flow, Water table, Precipitation (Atmospheric), Evapotranspiration, Water quality.  
Identifiers: \*Closed basins, Hydrologic systems.

In an area receiving approximately 34 in. average annual precipitation, the flow of groundwater was studied in the vicinity of 3 closed basins in glacial till. Piezometric data indicate that one of the basins was continually a groundwater discharge area, while the others alternated between recharge and discharge. Precipitation intensity, basin area, and geometry play significant roles in determining the frequency with which the closed basins convert from discharge areas to recharge areas. The water table rose adjacent to all three basins at some time during the study. Comparison of hydrographs of piezometers, precipitation data, and the level of marshes within the closed basins indicates a variable effect of precipitation on fluid potential and marsh level. Water quality data from the piezometers and from marshes in the basins suggest that the concentrations of dissolved solids are too low for a continuous discharge area. Basin area and shape influence the alternation of a given basin between recharge and discharge conditions. Given the appropriate distribution of precipitation, it appears that any basin of the type described herein can be expected to convert from a discharge to a recharge area at some time. All of the basins examined have had either surface water or groundwater outlets at some time. (Llaverias-USGS)  
W69-03119

**TRACE AND TRACER ELEMENTS IN GROUND WATER,**  
Arizona Univ., Tucson. Dept. of Hydrology.  
Gordon R. Dutt.

Arizona Water Resources Research Center, Research Project Technical Completion Report, August 1968. 11 p, 1 tab, 2 ref. OWRR Project B-001-Ariz, B-002-Ariz, and B-004-Ariz.

Descriptors: \*Ground water, \*Trace elements, Chelate extraction, Atomic absorption analyses, Carbonate, Bicarbonate, Fluoride, Nitrate, Sulfate, Silicate, Ground water recharge, Hydrochemical facies, Sewage effluent, C.O.D., B.O.D., Waste waters, Hydraulic loading, Infiltration, Tucson Basin, Process-response model, Instrumentation, Hydrochemical data.

Over 680 wells are sampled and analyzed for conductivity, pH, Ca (++), Mg (++), Na (+), Cl (-), SO4 (=), CO3 (=?), F (-), NO3 (-), K (+), Sr (++), and the trace elements, Fe, Mn, Cu, Zn, Cr (+6), Ni, Pb, Co, and Cd. A new method was developed for the simultaneous chelate extraction and atomic absorption analysis of the last nine elements in water and sewage samples. The surface and subsurface movement of the nine trace elements were stu-

died on grassed plots with effluent from a domestic sewage effluent treatment facility. Analysis of recharged water was the same as above plus C.O.D. and B.O.D. determinations. A conceptual process-response model of the Tucson Basin was developed to relate ground water chemical composition to the soil, subsoil and geologic formations of the recharge and ground water flow pattern of the basin. A calcite-water chemical equilibrium model was used to determine the precipitation or dissolution of calcite in the basin aquifers.  
W69-03197

## 2G. Water in Soils

**AQUEOUS TRANSPORT OF DIELDRIN RESIDUES IN SOILS,**  
Cincinnati Univ., Ohio., Environmental Health Engineering.

For primary bibliographic entry see Field 05B.  
For abstract, see .  
W69-02801

**MISCIBLE DISPLACEMENT IN AN UNSATURATED GLASS BEAD MEDIUM,**  
Guelph Univ., (Ontario).  
H. K. Krupp, and D. E. Elrick.  
Water Resources Res, Vol 4, No 4, pp 809-815, Aug 1968. 7 p, 6 fig, 1 tab, 12 ref.

Descriptors: \*Porous media, \*Soil water movement, \*Mixing, Water structure, Pore pressure, Model studies, Tracers.  
Identifiers: \*Miscible displacement, \*Chemical transport, Unsaturated medium, Pore volumes.

In order to analyze the mixing behavior of solutes in a porous medium over a wide range of water contents, a series of miscible displacement experiments was conducted in an unsaturated glass bead medium, at constant average water content during each displacement. Variation in the form of the breakthrough curve with decreasing water content was not large and was not related in a simple way to the water content; however, there was a consistent shift of the breakthrough curve to the left of the relative concentration value of 0.5 and 1 pore volume and a long tail or slow approach to the final relative concentration of 1.0. Some of these effects may be attributed to the presence of 'stagnant' liquid in the pores. The earliest appearance of tracer in the effluent was observed at a saturation fraction in the range of 0.54 to 0.56. This behavior is largely the result of disorder in the sample liquid. Both filled and partially filled pores and pore sequences were present in different amounts and mixing was not simply related to moisture content. At the higher water contents, flow in filled pores was dominant, whereas at lower water contents flow in partially filled pores and surface films dominated the displacement. (Llaverias-USGS)  
W69-02810

**UNSTEADY SEEPAGE FLOW BETWEEN FULLY-PENETRATING TRENCHES,**  
Wisconsin Univ., Milwaukee; and Northwestern Univ., Evanston, Ill.

Gabor Karadi, Raymond J. Krizek, and Hameed Elnaggar.  
J Hydrol, Vol 6, No 4, pp 417-430, Aug 1968. 14 p, 9 fig, 3 ref.

Descriptors: \*Unsteady flow, Trenches, \*Seepage, Groundwater movement, Infiltration, Evaporation, Differential equations, Seepage losses, Water table, Dupuit-Forchheimer theory, Phreatic lines, Homogeneity, Isotropy, Experimental data, Matrix algebra, Groundwater, Drainage, Groundwater flow.

Identifiers: Boundary conditions, Drain spacing, Porous media flow.

The problem of unsteady seepage flow (including either evaporation or infiltration) between 2 fully-penetrating trenches is considered. The method of solution is based on matrix mathematics and has

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### Group 2G—Water in Soils

the advantages of being able to handle complicated boundary and initial conditions and to consider, step by step, the nonlinearity of the governing differential equation. Typical results are presented for a variety of boundary and initial conditions. Results calculated by this technique for one particular set of boundary and initial conditions exhibit better agreement with experimental data than results calculated by linearizing the governing field equation. (USBR)  
W69-02913

**NEUTRON MOISTURE METER CALIBRATION FOR USE IN SALINE SOILS,**  
California Univ., Davis.  
L. C. Benz, W. O. Willis, F. M. Sandoval, and D. R. Nielsen.  
*Agr Eng*, Vol 46, No 6, pp 326-327, June 1965. 2 p, 1 fig, 1 tab.

Descriptors: \*Nuclear moisture meters, Moisture content, \*Saline soils, Salinity, \*Calibrations, Moisture meters, Soil moisture, Soil moisture meters, Arid lands, Electrical conductance, \*On-site tests, Aqueous solutions, \*Sodium chloride.

Data presented in the paper emphasized the necessity of field calibration of neutron meters where salinity levels were high. Neutron meter count reductions occurred when readings were taken in aqueous sodium chloride solutions. Count reductions increased as the sodium chloride concentration increased. The accuracy of soil moisture determinations by neutron moisture meters was reduced by relatively high levels of soil salinity. The higher the soil salt content, the greater was the deviation from the master curve or field calibration curves obtained under nonsaline conditions. Field calibration of neutron-moisture-measuring equipment may be necessary in arid soils where salinity levels are high. (Blecker-Arizona)  
W69-02965

**SOIL-WATER MOVEMENT IN VAPOUR AND LIQUID PHASES,**  
Utah State Univ., Logan.  
S. A. Taylor, and J. W. Cary.  
*Unesco Arid Zone Research*, Vol 25, pp 159-165, 1965. 7 p, 3 fig, 1 tab.

Descriptors: \*Soil water movement, \*Liquids, \*Saturated soils, Soil moisture, Moisture content, Soil water, \*Gases, Soil physics, Flow measurement, Thermocline, Heat transfer, Fluctuation, Arid lands, Soil temperature, Soil pressure, Conductivity, Temperature, Equations.  
Identifiers: Heat flux, Vapor flux.

The procedure for measuring and separating the liquid and vapor flow of water in soil material that is subjected to a temperature difference under conditions of constant pressure and matric potential is considered in detail. Results indicate that the proportion of water transmitted in the liquid in response to a thermal difference increases with water content of the sample until, in saturated soil, there is no vapor transfer remaining. It appears that as soil dries out, the proportion of the total water transmission that occurs in the vapor phase increases to a maximum that is reached when the amount transmitted in the liquid phase becomes negligibly small in comparison. Methods used in the study could be applied to determine the soil-water movement in arid soils. (Blecker-Arizona)  
W69-02966

**GERMINATION OF PROMISING DESERT GRASS SEEDS UNDER DIFFERENT DEPTHS OF SOWING IN SANDY SOIL,**  
Central Arid Zone Research Inst., Jodhpur (India).  
A. K. Chakravarty, and C. M. Verma.  
*Ann Arid Zone*, Vol 7, No 1, pp 75-81, March 1968. 7 p, 2 tab, 2 chart.

Descriptors: \*Germination, \*Seeds, \*Grasses, \*Soil moisture, \*Sands, Arid climates, Pasture

management, Vegetation regrowth, Deserts, Depth, Temperature, Humidity, Evaporation, Moisture content.  
Identifiers: India.

Seeds of three perennial grass species viz, *Cenchrus ciliaris*, *Cenchrus setigerus* and *Panicum antidotale* were sown at depths of 1, 2, 4, 6, and 9 cm under irrigated nursery conditions at the Central Arid Zone Research Institute, Jodhpur, India. The soil moisture percentage in the different depths of sowing treatments varied from 8.1 to 10.9 on the different dates of sowing. Results indicated that the seeds show optimum germination when sown at shallow depths of 1 to 2 cm even under low moisture regime. All three grass species continued to germinate up to 28 days after sowing. (Blecker-Arizona)  
W69-02972

#### SOIL WATER FLUX BELOW A RYEGRASS ROOT ZONE,

California Univ., Davis.  
M. E. LaRue, D. R. Nielsen, and R. M. Hagan.  
*Agron J*, Vol 60, No 6, pp 625-629, Nov-Dec 1968. 5 p, 6 fig, 1 tab.

Descriptors: \*Soil water movement, Hydraulic conductivity, Moisture content, Perennial ryegrass, Soil profiles, Soil-water-plant relationships, Root zone, Evapotranspiration, Rates of application, Sampling, Field capacity, Variability, Water pressure, Frequency, Irrigation efficiency, Hydraulic gradient, Percolation, Gravimetry.  
Identifiers: \*Fluxes, Soil water pressure.

The objective of a study conducted in California was to assess the net water flux below the root zone of a rye grass crop irrigated with equal total quantities of water but applied at different frequencies. Soil water flux was computed using hydraulic conductivity values calculated from field-measured soil-water characteristics. Irrigation frequency influenced the amount of water moving into or out of the root zone. The nature of the hydraulics of a natural field soil, its variability in space, and its implications for the interpretation of soil-water depletion data were also presented. (Affleck-Arizona)  
W69-02975

#### COMPARISON OF THREE COMMERCIAL DRAIN TILES IN A HEAVY CLAY SOIL OF IMPERIAL VALLEY,

California Univ., Davis. Dept. of Water Science and Engineering.  
For primary bibliographic entry see Field 08G.  
For abstract, see .

W69-02977

#### FURROW SIZE, PLACEMENT, AND GRASS CULTURE EFFECTS ON VINEYARD IRRIGATION,

California Univ., Davis. Department of Water Science and Engineering; and Calif. Univ., Davis. Agricultural Extension Service.  
For primary bibliographic entry see Field 03F.  
For abstract, see .

W69-02978

#### CHAPARRAL FIRES CHANGE SOIL MOISTURE DEPLETION PATTERNS,

California Univ., Riverside. Dept. of Agronomy.  
C. M. McKell, J. R. Goodin, and C. C. Duncan.  
*Calif Agr*, Vol 22, No 11, pp 15-16, Nov 1968. 2 p, 1 fig, 1 tab.

Descriptors: \*Burning, \*Chaparral, \*Vegetation regrowth, \*Soil moisture, Competition, Grasses, Bouyoucos blocks, California, \*Moisture deficit, Withdrawal.  
Identifiers: Wildfires.

In the fall of 1964, a wildfire swept through 85 acres of chaparral covered hillsides near Lake Henshaw in San Diego County. The pattern of soil

moisture depletion was observed for three years on four sites in the burned area and on four similar sites in the adjacent unburned area using gypsum electrical resistance blocks. During the first year, very large differences in soil moisture depletion between the burned and unburned areas were evident. Soil moisture depletion on the burned area during the second year after the fire was essentially the same as on the nearby unburned area. By the end of the third year the volume of chaparral regrowth had developed to such an extent that soil moisture depletion occurred earlier on the burned area than on the unburned area. This study showed that the period of favorable soil moisture for the establishment of perennial species as a replacement for chaparral was very short, under natural conditions. (Affleck-Arizona)  
W69-02979

#### PSYCHROMETRIC MEASUREMENT OF SOIL WATER POTENTIAL IN SITU UNDER COTTON PLANTS,

Commonwealth Scientific and Industrial Research Organization, Griffith (Australia). Div. of Irrigation Research.

A. R. G. Lang.  
*Soil Sci*, Vol 106, No 6, pp 460-464, Dec 1968. 5 p, 4 fig.

Descriptors: \*Soil moisture, Soil water movement, \*Moisture content, \*Cotton, \*Hygrometry, Soil-water-plant relationships, Root systems, \*Measurement, Instrumentation, Moisture uptake, Variability, Temperature, Absorption, Diurnal, Nocturnal, Translocation.  
Identifiers: \*Soil water potential, Water potential, \*Psychrometers.

Water potentials were measured directly and continually at 9 different positions in 16 liter volumes of soil, while water was removed via the roots of intact cotton plants in Australia. Measurements were made using Spanner thermocouple psychrometers inserted into cages previously buried in the soil. Water potentials displayed the expected patterns: water potential decreased more rapidly during the day than night, while day by day it decreased. The results confirmed by direct measurement, that cotton plants continue to withdraw water from soils at soil water potentials less than -3000J kg super -1. The apparatus, which may have application in the field, and the variability of results were discussed in detail. Part of the variability was probably caused by uneven distribution of roots. The probable error of the mean water potential at a given time was small relative to the changes in water potential with time. (Affleck-Arizona)  
W69-02980

#### PRECISION LYSIMETRY FOR DIRECT MEASUREMENT OF EVAPORATIVE FLUX,

Agricultural Research Service, Tempe, Ariz. Water Conservation Lab.

C. H. M. van Bavel, and R. J. Reginato.

UNESCO, Arid Zone Research, Vol 25, pp 129-

137, 1965. 7 p, 9 fig, disc.

Descriptors: \*Lysimeters, Measurement, \*Soil water, \*Moisture content, Water loss, \*Evaporation, Fluctuation, Electrical equipment, Instrumentation, Logging (Recording), Moisture tension, Data collections, Air-earth interfaces, Weight, Environmental effects.  
Identifiers: Evaporation flux, Fluxes.

The article describes the precision automated weighing lysimeter installation at the United States Water Conservation Laboratory, Tempe, Arizona. Details regarding mechanical and electrical features together with examples of the performance of the system were given. The system allowed for various forms of recording. One distinct advantage of lysimeters for measuring evaporative flux as compared to other methods was that they could be simply calibrated. The sensitivity of the system is between 10 and 20 grams. Precautions were taken to ensure that the lysimeter soil and the environ-

ment it provided for any crops grown therein were similar to that existing in its immediate environment. Moisture content in the lysimeter was slightly higher since the soil, having been artificially compacted, was devoid of those large pores that would result from continued activity of soil organisms and plant roots. (Blecker-Arizona)  
W69-02981

**SOIL STUDY FOR WATER ECONOMICS,**  
Institut za Vodoprivrednu Jaroslav Cerni, Belgrade  
(Yugoslavia).  
Ljubomir Grujic, Nikola Plamenac, and Predrag Marinkovic.  
Translation from Proc Institut za Vodoprivrednu 'Jaroslav Cerni', Vol 14 No 41-42, pp 113-122, 1967. TT67-58016.

Descriptors: \*Soil water, \*Irrigation, \*Drainage, Hydrogeology, Soil structure, Soil water movement, Soil physics, Hydrology, Return flow.  
Identifiers: Yugoslavia.

The study of soil hydrology in Yugoslavia from 1947-1967 is reviewed and a bibliography is listed. The topics covered are hydrophysical properties, structural properties, drainage methods and results, irrigation and irrigation return water, and efficiency of irrigation on various soils and crops. (Knapp-USGS)  
W69-03042

**AN ANALYSIS OF TEMPERATURE BEHAVIOR IN IRRIGATED SOIL PROFILES,**  
California Univ., Davis. Department of Water Science and Engineering.  
P. J. Wierenga.  
Calif Univ Water, Sci and Eng Pap 7002, 152 p., Sept 1968. 34 fig, 8 tab, 95 ref, 3 append.

Descriptors: \*Irrigation water, \*Soil temperature, \*Soil water, Heat budget, Experimental farms, Water temperature, Thermal properties, Diffusivity, Fourier analysis.  
Identifiers: Soil temperature changes, Irrigation water temperature.

A detailed analysis of the temperature pattern in irrigated soil, determining the effect on temperature of water of various amounts and temperatures, was made by energy-budget methods. A simplified model to predict soil temperature changes after irrigation with warm or cold water was tested in an instrumented experimental plot. The soil temperature, water content, net radiation, evaporation, bulk density, heat capacity, particle size distribution, and soil chemical composition were determined. Soil thermal conductivity was measured and compared with theoretical values of de Vries' model. Accurate predictions of temperature changes caused by irrigation depends on knowledge of the amount and temperature of water applied, temperature and heat capacity of soil before irrigation, and soil-water content before and after irrigation. Harmonic analysis of diurnal temperature fluctuation in soil yielded apparent thermal diffusivity values which agreed with thermal conductivity calculations and field measurements. (Knapp-USGS)  
W69-03053

**TRANSPORT IN SOILS: THE BALANCE OF MOMENTUM,**  
Forest Products Lab., Madison, Wisconsin; and Illinois Univ., Champaign.  
P. A. C. Raats, and A. Klute.  
Soil Sci Soc of Amer Proc, Vol 32, No 4, pp 452-456, July-Aug 1968. 5 p, 30 ref.

Descriptors: \*Flow, \*Porous media, \*Momentum equation, Compressible flow, Saturated flow, Soil water movement, Darcys law.  
Identifiers: Multiphase flow, Non-rigid porous media.

Soil fluid-phase movement is discussed on the basis of a balance of momentum for each phase in saturated as well as unsaturated soils with one or more fluid phases. Darcy's law is a special case of the relations presented, which account for several compressible as well as incompressible fluid phases moving through solid phase porous media which are not necessarily stationary, rigid, or isotropic. Various limiting assumptions are discussed and as one case, the form of Darcy's law for soils in which the solid phase undergoes deformation during fluid flow, is deduced. (Knapp-USGS)  
W69-03071

#### VELOCITY-GRADIENT RELATIONSHIPS FOR STEADY-STATE UNSATURATED FLOW OF WATER IN NON-SWELLING ARTIFICIAL SOILS,

Department of Agriculture, Brookings, S. D.; and Purdue Univ., Lafayette, Ind. Dept. of Agronomy. T. C. Olson, and D. Swartzendruber.  
Soil Sci Soc of Amer Proc, Vol 32, No 4, pp 457-462, July-Aug 1968. 6 p, 10 fig, 22 ref.

Descriptors: \*Unsaturated flow, \*Porous media, \*Soils, Clays, Kaolinite, Darcys law, Steady flow, Soil water movement, Soil water, Tension, Tensiometers.  
Identifiers: Non-swelling clay soils.

The relationship between flow velocity and hydraulic gradient was studied for steady-state unsaturated flow of water in horizontal columns of two nonswelling porous media, one a mixture of sand, ground silica, and kaolinite, and the other a mixture of sand and ground silica only. The flowing water contained 0.1% phenol to inhibit bacteria. Soil-moisture tension was measured with three tensiometers positioned within the soil column. Gradients at different velocities could be determined at a single location. Tension changes were always from low to high, to eliminate hysteresis effects. This required the use of a graphical analysis to calculate corresponding values of velocity and gradient at a given constant tension. In general, essential proportionality between flow velocity and tension gradient at given tension was found for both materials. Very slight greater-than-proportional tendencies were present in the sand-kaolinite mixture, but were not consistently related to tension. In the sand-silica mixture less-than-proportional flow response was observed at low and intermediate tensions, but became proportional as the tension increased. Minimal pore-volume saturations achieved were 0.74 for the sand-silica-kaolinite, and 0.65 for the sand-silica. (Knapp-USGS)  
W69-03072

#### MOVEMENT OF WATER TAGGED WITH (2)H, (3)H, and (18)O THROUGH ACIDIC KAOLINITIC SOIL,

Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.  
John C. Corey, and J. H. Horton.

Soil Sci Soc of Amer Proc, Vol 32, No 4, pp 471-475, July-Aug 1968. 5 p, 3 fig, 2 tab, 45 ref.

Descriptors: \*Soil water movement, \*Tracers, Tritium, Deuterium, Model studies, Infiltrometers.  
Identifiers: Miscible displacement, Oxygen isotopes.

Miscible displacement techniques were used to compare the behavior of deuterium, tritium, and oxygen-18 as water tracers. Displacement of a 170-mm portion of triply tagged water through a 186-cm-long column of water-saturated acidic kaolinitic soil by distilled water revealed no differences in the relative rates of movement of deuterium-, tritium-, and oxygen-18-tagged water. (Knapp-USGS)  
W69-03073

#### DETECTION OF SATURATED INTERFLOW IN SOILS WITH PIEZOMETERS,

Tennessee Valley Authority, Knoxville.

For primary bibliographic entry see Field 07B.  
For abstract, see .  
W69-03074

#### ROLE OF SOILS AND SEDIMENT IN WATER POLLUTION CONTROL—PART I, REACTIONS OF NITROGENOUS AND PHOSPHATIC COMPOUNDS WITH SOILS AND GEOLOGIC STRATA,

Federal Water Pollution Control Administration, Washington, D. C.

For primary bibliographic entry see Field 05E.  
For abstract, see .  
W69-03080

#### RELATION OF SOIL PROPERTIES TO THE EVAPORATION OF WATER FROM SOILS,

Clemson Univ., S. C. Agricultural Experiment Station.

For primary bibliographic entry see Field 02D.  
For abstract, see .  
W69-03175

#### MOVEMENT OF WATER FROM CANALS TO GROUNDWATER TABLE,

Idaho Univ., Moscow. Dept. of Civil Engineering; and Idaho Univ., Moscow. Dept. of Agricultural Engineering.

C. E. Brockway, and G. L. Bloomsburg.  
Technical Completion Report, Water Resources Research Institute, Sept 1968. 7 p, 1 fig, 7 ref. OWRR Project A-009-Ida.

Descriptors: \*Seepage, Canals, Irrigation, \*Tensiometers, Permeability, Unsaturated flow, Hydraulic conductivity, \*Groundwater.  
Identifiers: Southern Idaho.

Investigation of the mechanics of water movement from irrigation canals to the water table has been performed on selected canals in southern Idaho. Field studies of existing seepage measurement techniques including ponding tests, inflow-outflow techniques and seepage meters were made. A new seepage meter which will operate efficiently in large operating canals was developed. An accurate and reliable tensiometer system for monitoring changes in soil moisture pressure beneath operating canals was developed. Measured decreases in soil moisture and pressure beneath an operating canal during the irrigation season indicated decreasing seepage rates caused by natural sealing of a thin soil layer on the canal bottom. A fast response, inexpensive null point tensiometer was laboratory tested and a device for measuring the capillary pressure - saturation curve for soils in situ was investigated. New techniques for obtaining and testing undisturbed soil cores using heat shrinkable tubing allow efficient laboratory determination of hydraulic characteristics.  
W69-03179

#### DRAINAGE THEORY FOR REMOVAL OF EXCESS WATER FROM IRRIGATED LANDS,

Washington State Univ., Pullman. Dept. of Agricultural Engineering.

For primary bibliographic entry see Field 04A.  
For abstract, see .  
W69-03189

#### ADSORPTION OF PESTICIDES ON EARTH MATERIALS,

Massachusetts Univ., Amherst.

For primary bibliographic entry see Field 05G.  
For abstract, see .  
W69-03192

#### NON-DARCY FLOW CHARACTERISTICS OF WATER AS INFLUENCED BY CLAY CONCENTRATION,

Illinois Univ., Urbana. Dept. of Agronomy.  
Raymond J. Miller, Allen R. Overman, and John H. Peverly.

## Field 02—WATER CYCLE

### Group 2G—Water in Soils

Water Resources Center, Research Report No. 16, June 1968, 50 p, 3 tab, 11 fig, 33 ref. OWRR Project B-002-Ill.

Descriptors: \*Clays, Flow, Hydraulic conductivity, Saturated flow, Saturated soils, \*Soil water movement, Ground water movement, Porous media, Montmorillonite, Kaolinite, Darcy's Law, Flow characteristics, Flow rates, \*Flow measurement. Identifiers: \*Non-Darcy flow, Threshold gradients, Pressure transducers.

The flow of water through saturated samples of montmorillonite and kaolinite was studied to help clarify the existence and nature of non-Darcian flow. No threshold gradients were found in any of the samples studied. Non-Darcy flow was found in 9, 30 and 40 weight percent montmorillonite samples but not in a 50 weight percent montmorillonite or in kaolinite samples. The possible causes of the non-Darcian flow are discussed. A refined technique using a pressure transducer was developed to measure hydraulic conductivities. The hydraulic conductivities of several types of samples under varying conditions were measured. Transport equations for convective diffusion in porous media were derived and tested for capillaries, porous diaphragms, sand columns and clay plugs.

W69-03195

## 2H. Lakes

### PREDICTING DISSOLVED OXYGEN CONCENTRATION IN A LAKE COVERED WITH EVAPORATION SUPPRESSANT,

Bovay Engineers, Inc., Houston, Tex.

For primary bibliographic entry see Field 02D.

For abstract, see .

W69-02825

### EVALUATION OF SEEPAGE FROM CHESTER MORSE LAKE AND MASONRY POOL, KING COUNTY, WASHINGTON,

Geological Survey, Washington, D. C. Water Resources Div.

F. T. Hidak, and A. A. Garrett.

U S Geol Surv Water-Supply Pap 1839-J, 1967. 26 p, 9 fig, 7 tab, 7 ref.

Descriptors: \*Reservoir leakage, \*Surface waters, \*Streamflow, \*Washington, Seepage, Water loss, Regression analysis, Runoff, Hydrographs. Identifiers: Runoff regimen change, Losing stream, Gaining stream, King County (Washington).

Hydrologic data collected in the Cedar and Snoqualmie River basins on the west slope of the Cascade Range were analyzed to determine the amount of water lost by seepage from Chester Morse Lake and Masonry Pool and the consequent gain by seepage to the Cedar and South Fork Snoqualmie Rivers. Average losses for water years 1957-64 were about 220 cfs while average gains were about 180 cfs in the Cedar River and 50 cfs in the South Fort Snoqualmie River. Streamflow and precipitation data for water years 1908-26 and 1930-32 indicate that a change in runoff regimen occurred in Cedar and South Fork Snoqualmie Rivers after the Boxley Creek washout in December 1918. For water years 1919-26 and 1930-32, the flow of Cedar River near Landsburg averaged about 80 cfs less than it would have if the washout had not occurred. In contrast, the flow of South Fork Snoqualmie River at North Bend averaged about 60 cfs more than it would have. (Steinheimer-USGS)

W69-02827

### SEASONAL CHANGES OF SLOUGH AND LAKE WATER CHEMISTRY IN SOUTHERN SASKATCHEWAN (CANADA),

Institut Geologiczny, Sosnowiec (Poland).

A. D. Rozkowska, and A. Rozkowski.

J Hydrol, Vol 7, (1969), No 1, pp 1-13, pub Nov 1968. 13 p, 4 fig, 4 tab, 7 ref.

Descriptors: \*Water chemistry, \*Lakes, \*Saline water systems, \*Evaporation, Water quality, Sulfates, Hydrogen ion concentration, Calcium, Magnesium, Carbonates, Bicarbonates, Chlorides. Identifiers: \*Canada, Saskatchewan.

Detailed hydrochemical studies of lakes and sloughs in the Moose Mountain area of Southern Saskatchewan show an increase of the water salinity and the enrichment of waters with easily soluble salts during the summer season. Concurrently, there was observed precipitation of the poorly soluble salts. The salinity and chemistry of the large lakes vary less than that of the smaller sloughs. Degree of salinity increase depends on the hydrological and hydrographical conditions as well as on the biological environment. The highly mineralized shallow sloughs located in deep kettles show increases of salinity during summer of 200 to 300% and particularly a sharp rise of sulfate and magnesium ions. (Knapp-USGS)

W69-02838

### DWINDLING LAKES,

Wisconsin Univ., Madison, Lab. of Limnology.

Arthur D. Hasler, and Bruce Ingersoll.

Nat Hist, Vol 77, No 9, pp 8+, Nov 1968. 6 p, 1 fig, 1 tab.

Descriptors: \*Cyanophyta, \*Plant growth, \*Eutrophication, Agricultural watersheds, Aquatic weed control, Alicides, Fertilization, Great Lakes, Great Lakes region, Harvesting, Impoundments, Lake stages, Maine, Nutrients, Oligotrophy, Rivers, Sewage, Systems analysis, Water pollution, \*Lakes.

Identifiers: Oscillatoria rubescens, Lake Zurich (Switzerland), Cochran Lake (Wis), Lake Tahoe (Calif), Lake Monona (Wis), Upper Klamath Lake (Ore), Lake Sallie (Minn), Lake Mendota (Wis), Moses Lake (Wash), Lake Washington (Wash), Lake Kegonsa (Wis), Lake Waubesa (Wis), Crater Lake (Ore), Lake George (NY), Lake Cayuga (NY), Lake Okoboji (Iowa), Douglas Lake (Mich), Lake Okeechobee (Fla), Lake Apopka (Fla).

Eutrophication and subsequent extinction of lakes is a naturally occurring process whose rate is governed by many limnological and geological factors. Man's activities, including waste disposal and agricultural practices, substantially hasten the process by polluting rivers, lakes and impoundments with excessive plant nutrients. Consequent growth of blue-green algae and rooted aquatic vegetation initiate a cycle of events which are aesthetically offensive and economically costly. Authors classified 12 selected American lakes as follows: excellent—Crater, Ore; excellent but endangered—Superior and Tahoe; good but endangered—George and Cayuga, NY; fair but improving—Washington, Seattle; good and improving—Okoboji, Iowa; fair and endangered—Mendota, Wis; poor and endangered—Erie; good but endangered—Douglas, Mich; and Okeechobee, Fla; and poor but improving—Apopka, Fla. Authors discuss diversion, improved sewage treatment, enlightened agricultural practices, and harvesting as methods of control, but discourage techniques such as application of biocides, which treat effects without eliminating nutrients. Air pollution is involved as source of nitrogen pollution via rainfall. Authors urge more and careful study of manifold factors influencing eutrophication and indicate the great promise of systems analysis as means of generating large-scale data needed for control.

W69-02956

### FERTILIZATION OF NATURAL LAKES IN MICHIGAN,

Michigan State Univ., East Lansing Dept. of Zoology.

Robert C. Ball.

Trans Amer Fish Soc, Vol 78, pp 145-155, 1948. 16 p, 3 fig, 2 tab, 9 ref.

Descriptors: \*Lakes, \*Eutrophication, \*Fertilization, \*Michigan, Phosphorus, Nitrogen, Nutrients, Pondweeds, Water pollution effects, Winterkilling,

Oxygen requirements, Marginal productivity, Trout, Diptera, Pan fish, Invertebrates, Fish management, Pikes, Minnows, Bull heads.

Identifiers: Secchi disk, Lower Peninsula (Mich), North Twin Lake, Cheboygan County (Mich), Otsego County (Mich), South Twin Lake, Hybrid sunfish, Solution lakes, Nymphae, Comparative studies.

During summers of 1946 and 1947, high-nitrogen, high-phosphorus commercial fertilizer (10-6-4) was applied at 3-week intervals of two Michigan lakes—a warm-water lake and a trout lake. Two fairly similar adjacent lakes served as unfertilized controls. Both summers, the equivalent of 2 ppm/week of fertilizer (ie, 2800 lb) was supplied to the warm-water lake; the smaller trout lake received the equivalents of 2 ppm/week (ie, 400 lb) in 1946 and 3 ppm/week in 1947. The former responded with planktonic algae bloom during the first summer and with a dense growth of filamentous algae the second. The trout lake, where Secchi disk readings were not less than 8.2 feet, responded less markedly to added nutrients, although total alkalinity increased from original 48 ppm to 53 ppm, as compared to a steady 41 ppm in control. Little oxygen depletion occurred in treated lakes during first post-treatment winter; however, in February 1948 oxygen decreased below 1 ppm at all depths. In both treated lakes, winterkill of fishes and invertebrates resulted. No observable winterkill occurred in control lakes. Author emphasizes need for further research and discourages indiscriminate fertilization of lakes as a management technique. (Wisc)

W69-02957

### LONG-TERM CHANGES IN WATER CHEMISTRY AND ABUNDANCE OF PLANKTON AT A SINGLE SAMPLING LOCATION IN LAKE ONTARIO,

Ontario Water Resources Commission, Toronto; and Municipality of Metropolitan Toronto (Ontario). Dept. of Works.

C. F. Schenk, and R. E. Thompson.

Publication Number 13, Great Lakes Res Div, Univ Mich, pp 197-208, 1965. 12 p, 6 fig, 1 tab, 15 ref.

Descriptors: \*Lake Ontario, \*Water chemistry, \*Plankton, Water pollution effects, Annual succession, Phytoplankton, Regression analysis, Ammonia, Chlorides, Hardness (Water), Sampling, Analytical techniques, Hydrogen ion concentration, Eutrophication, Oligotrophy, Bioindicators, Protozoa, Rotifers, Diatoms.

Identifiers: Canada, Toronto Island Filtration Plant (Ontario), R V Port Dauphine, R C Harris Filtration Plant (Ontario), Comparative studies, *Mallomonas*, *Anabaena*, *Cladophora*, *Vorticella*, *Oscillatoria*, Plankton abundance, *Synura*, *Dinobryon*, *Fragilaria*, *Tabellaria*, *Syndra*, *Stephanodiscus*, *Cyclotella*, *Melosira*, *Ulothrix*, *Codonella*, *Actinophrys*.

Depending upon wind conditions, the intake of Toronto Island Filtration Plant, Ontario, samples epilimnetic or hypolimnetic waters of Lake Ontario. Evaluation of data accumulated from 1923 to 1954 indicated that the level of plankton approximately doubled during this period. Levels of free ammonia, chlorides, hardness and turbidity continued to increase through 1964. Turbidity levels and concentration of free ammonia in the 'raw' water were substantially greater than those obtained farther out in the lake. As determined from a highly statistically significant linear regression, mean increase in plankton was computed at 5.6 areal standard units (asu) per annum with confidence limits (95%), 3-7 asu/year. Well-defined spring maximal and winter minimal populations were apparent nearly every year, but fall maxima developed inconsistently and were characterized by levels of abundance lower than those for the spring pulses. No definite changes in the duration of spring maxima were evident in later years, but an alteration in the pattern of diatom dominance emerged after 1940. Between 1925 and 1940, *Asterionella* dominated the spring pulse in 13 of 16

## Lakes—Group 2H

years. Beginning in 1941, *Cyclotella* became an important constituent of the maximum, sharing dominance with *Asterionella* in 6 of 14 years, and being the dominant species in three additional years. (Wisc) W69-02958

**PRIMARY PRODUCTIVITY STUDIES IN ONONDAGA LAKE, NEW YORK,**  
Syracuse Univ., N. Y. Dept of Civil Engineering.  
For primary bibliographic entry see Field 05C.  
For abstract, see .  
W69-02959

**THE CHEMISTRY OF LAKE SEDIMENTS FROM INDIAN TIBET,**  
Yale Univ., New Haven, Conn. Osborn Zoological Lab.

G. E. Hutchinson, Anne Wollack and Jane K. Setlow.

Amer J Sci, Vol 241, No 9, pp 533-542, Sept 1943.  
11 p, 1 fig, 2 tab, 11 ref.

Descriptors: \*Lakes, \*Geochemistry, \*Sediments, \*Water chemistry, \*Lake stages, Silica, Manganese, Eutrophication, Oligotrophy, Magnesium, Calcium, Chlorides, Analytical techniques, Aluminum, Phosphorous compounds, Nitrogen compounds, Potassium compounds, Stratigraphy, Iron, Titanium.

Identifiers: \*India, \*Tibet, Mesotrophy, Yaye Tso, Sta-tsa-puk Tso, Tso Morir, Mitpai Tso, Khyagar Tso, Panggong Tso, Tso Kar, Pyramid Lake (Nevada), Linsley Pond (Connecticut), Closed lakes, Open lakes, Lake origins, Ekman-Birge grab, Strontium, Comparative studies, Barium, Ororotse Tso.

Calcium content of lake sediments is correlated with presence or absence of an outlet. Magnesium increases only in sediments of more concentrated closed lakes. Strontium appears to follow calcium, but strontium content is probably also controlled lithologically. Barium is probably sedimented with the silt fraction and is independent of water chemistry. Calcium content of the deep sediment of Panggong Tso has clearly undergone changes, presumably owing to a fall in water level. Author suggests that study of samples from long cores, either by gravimetric analysis of CaO and SiO<sub>2</sub> sub 2 or by spectrographic comparison by Sr and Ba should make possible the recognition of periods of high and low levels in a lake's history. The mean phosphorus content of the sediment ash is 0.10%, little above the mean geochemical value of 0.08%. Loss of phosphorus from water by precipitation as Ca sub 3 (PO<sub>4</sub> sub 2) sub 2 is clearly of little importance in the economy of even the closed alkaline lakes. The ratio of combined nitrogen to phosphorus varies from 1.7 to 7.8; such low values are regarded as characteristic of relatively oligotrophic lakes. The proximate composition of the organic matter is essentially as in other harmonic lake sediments. (Wisc)

W69-02960

**ONONDAGA LAKE, NEW YORK, AN UNUSUAL ALGAL ENVIRONMENT,**  
Syracuse Univ., N. Y. Dept. of Civil Engineering.

Daniel F. Jackson.

For publication in 'Algae, Man, and the Environment,' Syracuse Univ Press, 1968. 19 p. NY Dept. of Health C-19638.

Descriptors: \*Algae, \*Bioassay, \*Bioindicators, \*Eutrophication, Plant growth, Chlorophyta, Chrysophyta, Cyanophyta, Euglenophyta, Diatoms, Lakes, Meromixis, Sewage effluents, Sewage treatment, Water pollution effects.

Identifiers: \*Onondaga Lake (New York), Cladophora, Enteromorpha intestinalis, Anabaena, Anacystis, Gloeocapsa, Gloeotrichia, Synecchococcus, Cyclotella, Navicula, Nitzschia, Pinnularia, Gomphonema, Amphora, Eunotia, Saturoneis, Carteria, Chlamydomonas, Gonium, Ankistrodesmus, Chlorella, Microspora, Pediastrum,

Halochlorococcum, Scenedesmus, Euglena, Lepocinclis.

Made highly brackish (1700-1960 ppm chloride) from inflow of saline springs, Lake Onondaga, NY, is thought to be meromictic. Although subject to heavy influences of cultural eutrophication and industrial pollution, lake fails to bloom with cyanophytes, but annual blooms of chlorophytes and euglenophytes have occurred in summers since 1962. Author speculates that scarcity of cyanophytes may result from salinity, from growth inhibition by high calcium concentrations (typical analysis: 472 mg/L as ion), or from decreased mineralization of allochthonous organic matter. Preliminary to a study of effects on lake of replacing existing primary treatment sewage plant with a planned secondary type, a bioassay was devised. Five species of cyanophytes, 8 chrysophytes, 10 chlorophytes, and 2 euglenophytes were cultured in 5 concentrations of filtered lake water enriched with appropriate growth medium held for 10 days at 25 deg C and at a diel cycle of 14 hours light (400 lux), 10 hours dark. Cyanophytes did not grow in unenriched lake water. Evaluated in cells/liter, following forms grew better in unenriched lake water than in undiluted growth medium to extent indicated by multiplicative factor in parentheses: diatom-Cyclotella (119); chlorophytes-Halochlorococcum (15); Chlorella (Milford strain) 9; Chlamydomonas (16). W69-02961

**A NOTE CONCERNING THE EDDY TRANSFER COEFFICIENTS OF MOMENTUM AND WATER VAPOR UNDER NEAR-ADIABATIC CONDITIONS,**

Geological Survey, Denver, Colo.

For primary bibliographic entry see Field 02D.  
For abstract, see .  
W69-03051

**SYSTEMS APPROACH TO WATER QUALITY IN THE GREAT LAKES.**

Proc of 3rd Annual Symp on Water Resources Res, Ohio State Univ Water Resources Center, 130 p, Sept 1967. OWRR A-999-Ohio.

Descriptors: \*Systems analysis, \*Great Lakes, \*Lake Erie, \*Water quality, Eutrophication, Water pollution, Water pollution control, Management, Model studies.

A symposium on the subject of using the systems approach to water quality in the Great Lakes, particularly Lake Erie, was held at Ohio State University, September 1967. It was agreed that Lake Erie water quality changed markedly in the past 70-100 years in temperature, ecology, and suspended and dissolved solids, but the cause has not been firmly established. Pollution, invasion by marine organisms, natural eutrophication, and other causes are all involved. A systems approach helps solve the problem by pointing out inadequacies in knowledge and in conceptual, mathematical, and computer models used as tools, and when sufficient good evidence has been collected, systems methods are powerful tools for problem solving and management. The general conclusion is that a systems-modeling approach to quality problems in the Great Lakes is feasible and should be instigated as soon as possible on as large a geographical scale as possible. (Knapp-USGS)

W69-03059

**ADSORPTION OF PHOSPHORUS BY LAKE SEDIMENT,**

Connecticut Agricultural Experimental Station, New Haven.

Robert D. Harter.

Soil Sci Soc of Amer Proc, Vol 32, No 4, pp 514-518, July-Aug 1968. 5 p, 5 fig, 1 tab, 12 ref.

Descriptors: \*Adsorption, \*Phosphorus compounds, \*Lakes, \*Sediments, \*Eutrophication, Algae, Clays, Silicates.

Identifiers: Extractable phosphorus.

To study the mechanism of sorption of phosphorus by eutrophic lake sediments, between 0 and 2.2 mg P was added to 0.1-g sediment samples at a 1:50 sediment-solution ratio. After equilibrium had been established, P remaining in solution was determined, and adsorbed P was extracted with 0.5N ammonium fluoride and 0.1N NaOH. Whereas all P adsorbed into the NaOH-extractable fraction appeared to occur as an iron phosphate, ammonium fluoride apparently extracted P bonded by two different mechanisms. When less than about 0.1 mg P was added, ammonium fluoride extracted a tightly bonded form of P, probably occurring as an aluminum phosphate. When more than 0.1 mg P was added, additional P in a more loosely bonded form was absorbed into the ammonium fluoride-extractable fraction. The loosely bonded P appeared to be independent of Al content of the sediment, and could be removed by successive water extraction. The capability of the sediment to adsorb considerable loosely bonded P means that large influxes of P into the lake may be held temporarily and subsequently released to growing plants and algae. (Knapp-USGS)

**ANALYSIS OF WATER AND WATER-RELATED RESEARCH REQUIREMENTS IN THE GREAT LAKES REGION.**

Michigan Univ., Ann Arbor.

For primary bibliographic entry see Field 07A.  
For abstract, see .  
W69-03079

**EVAPORATION FROM LARGE DEEP LAKES,**

Great Lakes-St. Lawrence Study Office, Cornwall (Ontario). Dept. of Mines and Technical Surveys.

For primary bibliographic entry see Field 02D.  
For abstract, see .  
W69-03083

**A SURVEY AND EVALUATION OF SMALL ARTIFICIAL RECREATIONAL PONDS IN CENTRAL MASSACHUSETTS,**  
Massachusetts Univ., Amherst.

James A. McCann, Eugene F. Zanella, and Larry R. Scofield.

Proj Completion Rep. Mass Univ Water Resources Res Inst Rep, 2 theses, 2 parts, total 226 p, Oct 1968. Total 19 fig, 39 tab, 82 ref, 10 append. OWRR: A-001-Mass.

Descriptors: \*Farm ponds, \*Multiple-purpose reservoirs, \*Limnology, \*Massachusetts, Recreation, Fishing, Swimming, Stock water, Fish management, Water storage.

Identifiers: Fire protection ponds, Skating ponds, Multiple-purpose farm ponds.

A survey of the physical, biological, and chemical properties and water uses of 167 small artificial ponds in Hampshire County, Massachusetts, and a detailed limnological evaluation of 12 of them showed that land uses and geographical features seriously affect their multiple use. In the past, ponds in Hampshire County were constructed primarily for fire protection and livestock watering, while skating, swimming, and fishing were secondary. Satisfying angling desires is the most difficult use to achieve in a pond. Weed control and species composition regulation work must be done annually. The most common difficulties are low acidity, dense algal blooms, periods of deficient oxygen, and drought. Many of the ponds studied had no recreational use because of incorrect construction, conflicting uses, or lack of annual management. The most serious problems are in ponds being used for purposes other than those originally planned. (Knapp-USGS)

W69-03086

**CHEMICAL AND ISOTOPIC BALANCES FOR A MEROMICTIC LAKE,**  
Lamont Geological Observatory, Palisades, N. Y.

## Field 02—WATER CYCLE

### Group 2H—Lakes

Taro Takahashi, Wallace Broecker, and Yuan Hui Li.  
Limnol and Oceanogr, Vol 13, No 2, pp 272-292,  
April 1968. 21 p, 10 fig, 11 tab, 23 ref.

Descriptors: \*Meromixis, \*Lakes, \*Chemical stratification, \*Stagnant water, New York, Sediments, Calcite, Photosynthesis, Carbon cycle, Supersaturation.

Identifiers: \*Isotopic balance, \*Green Lake (N.Y.), Chemocline, Hydrologic transport.

Chemical and isotopic studies of the waters and sediments of Green Lake near Fayetteville, New York, are described and causes of the meromixis are defined. Stagnation results from water of two different types entering the lake. The water entering below the chemocline is almost twice as saline as the water entering the surface layer according to the hydrologic, isotopic, and chemical balances. For carbon and its isotopes, consideration is given to the contributions of CaCO<sub>3</sub> precipitation, the photosynthetic cycle, exchange of gas with the atmosphere, and hydrologic transport. A mean time residence of two years is indicated for surface water and of 4 to 30 yr for deep water. Although both surface and deep waters are supersaturated with calcite, the carbon isotope data indicate that precipitation occurs largely from the surface water. (Lang-USGS)  
W69-03088

#### SOME ASPECTS OF THE HYDROLOGY OF PONDS AND SMALL LAKES,

Minnesota Univ., St. Paul. Dept. of Agricultural Engineering.  
P. W. Manson, G. M. Schwartz, and E. R. Allred.  
Minn Univ Agri Exp Sta Tech Bull 257, 1968. 88 p, 55 fig, 40 tab, 14 ref. OWWR: A-001-Minn.

Descriptors: \*Potholes, \*Regimen, Groundwater recharge, Drainage, Minnesota, Water levels.

Information is presented on the annual regimen of about 40 small lakes and ponds (potholes) in an area extending from Mankato to Detroit Lakes, Minnesota. The usual regimen of a small body of water follows a general pattern. From Dec. 1 to about Apr. 1, the ponds normally have an ice cover and the water and ice level in most ponds is notably stable. During this period, seepage losses from 47 small water bodies were calculated to average about 0.0032 foot per day. Water levels begin to rise in the spring after ice break-up and the advent of the usual frequent rains; the crest of the rise may occur from mid-May to mid-June. Levels decline sharply from mid-June through August, because of high evaporation rates. From September to freeze-up, the decline becomes more gentle. These data indicate that the main factor controlling water levels in small, shallow lakes and ponds is the relation between precipitation and evaporation. A factor that controls flood levels is the permeability of the soil and drift that surround the ponds. These materials generally have a much higher permeability than those of the bottom of the pond, hence infiltration is rapid and significant during flood levels. (Steinhilber-USGS)  
W69-03091

#### AN INVESTIGATION OF THE EFFECT OF CONTROLLED RELEASES ON THE PHYSICAL, CHEMICAL AND BACTERIOLOGICAL CHARACTERISTICS OF FORT LOUDOUN RESERVOIR,

Tennessee Univ., Knoxville. Dept. of Civil Engineering.

For primary bibliographic entry see Field 05C.

For abstract, see .

W69-03180

#### UNDERWATER SOILS: A REVIEW OF LAKE SEDIMENTS,

Freshwater Biological Association, Ambleside (England).

C. H. Mortimer.

J Soil Sci, Vol 1, pp 63-73, 1949. 11 p, 1 fig, 35 ref.

Descriptors: \*Sedimentation, \*Sediment-water interfaces, \*Nutrients, \*Soil properties, Lakes, Metabolism, Seasonal Cycles, Stratification, Mud-water interface, Surface waters, Thermal stratification, Sampling, Drainage systems, Dissolved oxygen.

Identifiers: Seasonal changes, Mud-water relationship, Sediment-water relationship, Nutrient cycles, Surface sediments, Mud surface, Esthwaite Water, Bacteria in sediments, Animals in sediments, Biological productivity.

Sampling methods, factors which influence sedimentation, the role of sediments in lake metabolism, and the activities of bacteria and animals in sediments are reviewed. Sediments often record changes in such factors as extent of soil cover, cultivation or pollution. For a large drainage area compared with the lake area, most of the sediment parent material may be expected from inflows. Sediments affect the biological productivity in the lakes as a whole, especially with regard to their influence on the supply of plant nutrients. This is illustrated by seasonal changes in Esthwaite Water in the English Lake District with depth-time diagrams of the distribution of dissolved oxygen in the water, distribution of redox potential above and below the mud surface and concentration of some dissolved substances in water. Samples were taken approximately 10 cm above mud surface. Questions are raised concerning future studies of the sediment-water system.  
W69-03187

## 2I. Water in Plants

#### INFLUENCE OF THE FOREST ON PRECIPITATION,

State Hydrological Inst., Leningrad (USSR).

For primary bibliographic entry see Field 02B.

For abstract, see .

W69-02803

#### EFFECTS OF MOISTURE AND NITROGEN FERTILIZER ON GROWTH AND WATER USE BY NATIVE GRASS,

Agricultural Research Service, Washington, D. C.  
D. E. Smika, H. J. Haas, and J. F. Power.

Agronomy J, Vol 57, No 5, pp 483-486, September-October 1965. 4 p, 4 fig, 3 tab.

Descriptors: \*Soil moisture, Water utilization, \*Nitrogen, \*Grasses, \*Moisture availability, Soil-water-plant relationships, Semiarid climates, Precipitation (Atmospheric), North Dakota, Fertilizers, \*Crop response, Forage grasses, Plant growth.  
Identifiers: Water-use efficiency.

A study was conducted at Mandan, North Dakota, to determine the influence of available moisture supply and nitrogen fertilizer on yield, water use efficiency and recovery of nitrogen fertilizer by native grass. Production increased with each added increment of nitrogen, whether applied annually or only once the first year. Total water use was not affected by fertilizer nitrogen on the natural moisture treatment, but was increased about 1.5 inches with the addition of 160 pounds of nitrogen per acre on the high moisture treatment. Water-use efficiency increased as rate of fertilizer nitrogen increased and was related curvilinearly to available moisture supply. Recovery of fertilizer nitrogen by the forage was greater on the high moisture treatment than on the natural moisture treatment. Native grasses on arid soils are more efficient with respect to water when proper levels of nitrogen are maintained. (Blecker-Arizona)  
W69-02969

#### DETERMINING CONSUMPTIVE USE FOR PLANNING WATER DEVELOPMENTS,

California Univ., Los Angeles; and Clyde-Criddle-Woodward, Inc., Salt Lake City, Utah.

Harry F. Blaney, Sr., and Wayne D. Criddle.

Irrig Drainage Speciality Conference, American Society of Civil Engs, Las Vegas, Nevada, pp 1-34, November 2-4, 1966. 34 p, 8 tab, 32 ref, append.

Descriptors: \*Consumptive use, \*Water requirements, Water demand, Water resources development, \*Irrigation efficiency, \*Climatic data, Arid lands, Beneficial use, Crop production, \*Evapotranspiration, Irrigation water, Legal aspects, Temperature, Reclamation states, Solar radiation, Precipitation (Atmospheric), Interstate compacts.  
Identifiers: Blaney-Criddle method.

The purpose of this paper was to describe the Blaney-Criddle (B-C) method for estimating consumptive use and irrigation requirements for areas where few or no data, except limited climatological data, are available. Many terms used in the report are defined. The procedure was to correlate existing consumptive use data for different crops with monthly temperature, percent of daytime hours, precipitation, frost-free (growing) period, or irrigation season. The coefficients developed were used to transpose the consumptive-use data for a given area to other areas for which only climatological data were available. The method was found to be satisfactory for computing use where measured water-use data were not available. The described method can be used to determine the consumptive use for planning water developments in arid climates. (Blecker-Arizona)  
W69-02970

#### INVESTIGATIONS ON THE IRRIGATION REQUIREMENTS OF HYBRID MAIZE CROP IN ARID REGION OF PUNJAB,

Punjab Agricultural Univ., Hissar (India). Dept. of Agronomy.

For primary bibliographic entry see Field 03F.

For abstract, see .

W69-02973

#### SPRINKLER AND SURFACE IRRIGATION OF VEGETABLE AND FIELD CROPS IN AN ARID ENVIRONMENT,

California Univ., Berkeley.

For primary bibliographic entry see Field 03F.

For abstract, see .

W69-02974

#### PSYCHROMETRIC MEASUREMENT OF SOIL WATER POTENTIAL IN SITU UNDER COTTON PLANTS,

Commonwealth Scientific and Industrial Research Organization, Griffith (Australia). Div. of Irrigation Research.

For primary bibliographic entry see Field 02G.

For abstract, see .

W69-02980

#### GERMINATION IN LOWER OSMOTIC POTENTIAL AS AN INDEX OF DROUGHT RESISTANCE IN CROP PLANTS - A REVIEW,

Udaipur Univ. (India) Agricultural Experiment Station.

Man Singh Manohar, Suraj Bhan, and Ram Prasad.

Annals of Arid Zone, Vol 7, No 1, pp 82-92, March 1968. 11 p, 57 ref.

Descriptors: \*Germination, Seeds, Drought resistance, Soil moisture, Crop response, \*Osmotic pressure, Soil-water-plant relationships, Arid lands, Plant physiology, Moisture content, Field capacity, Salt tolerance, Biochemistry, Wilting point, Absorption, Moisture uptake.  
Identifiers: \*Osmotic potential, Polyethylene glycol.

A review of studies of 'Germination in lower osmotic potential as an index of drought resistance in crop plants' was presented. These studies show that little systematic work has been done in the past to confirm the prevailing hypotheses. Conflicting results have been reported by investigators working with various crop species, using different levels of osmotic potentials, produced from several different chemicals, and under varying environmental conditions. It was difficult, therefore, to conclude a

definite relationship between the germinability of seeds in lower osmotic potentials and its relation to drought resistance in the resultant crop plants. It was apparent from the review that most of the chemicals which have been used in the past may enter inside the germinating seeds and thus their effects are much more complex than producing drought. Recent work has shown, however, that the true osmotic stress may be produced by using polyethylene glycol solutions. (Affleck-Arizona) W69-02984

#### ROOT DEVELOPMENT IN RELATION TO PLANT POPULATION AND FERTILITY LEVELS IN SOYBEAN

Agriculture Coll., Kanpur (India).

M. N. Mishra, and A. N. Singh.

Annals of Arid Zone, Vol 7, No 1, pp 121-126, March 1968. 6 p, 3 fig, 2 tab.

Descriptors: \*Root development, \*Drought resistance, Arid lands, Fertilizer, Plant populations, \*Soybean.

In arid and semi-arid regions where moisture is almost always a limiting factor, the study of root development assumes a significant place. A sound and deep root system is an index of the ability of plants to withstand deficient moisture conditions and to absorb plant nutrients from deeper layers of the soil profile, thus affecting efficient utilization of plant nutrients. An experiment was conducted to study the effect of three plant populations (25, 50, and 75 cm spacing between rows) with 2 levels of nitrogen (0 and 10 kg/ha) and 5 levels of P sub 2 O sub 5 (0, 20, 40, 60, and 80 kg/ha) on root development of soybean T49. The length of the main root increased in 25 cm row spacing followed by 50 and 75 cm, while the reverse was true with number and weight of nodules per plant. Nitrogen had no marked influence on root development, but the application of phosphorus enhanced the length of the main root as well as the number and weight of nodules per plant. (Affleck-Arizona) W69-02985

#### PONTACYL BRILLIANT PINK AS A TRACER DYE IN THE MOVEMENT OF WATER IN PHREATOPHYTES

Geological Survey, Menlo Park, Calif.

T. W. Robinson, and Donald Donaldson.

Water Resources Res, Vol 3, No 1, pp 203-211, 1967. 9 p, 5 fig, 4 ref.

Descriptors: \*Evapotranspiration, \*Phreatophytes, \*Tracers, \*Dye releases, Soil moisture.

Identifiers: Fluorescent dye tracers.

In connection with evapotranspiration studies, Pontacyl Brilliant Pink, a fluorescent dye, was used to trace the movement of water in 2 species of woody phreatophytes, willow and wildrose. The dye was introduced into water surrounding the plant roots on August 4, 1964. Thereafter, leaf samples were collected periodically until the end of the growing season in October. Fluorometric measurements showed the presence of the dye in the leaves. Dye was also found in samples of roots and stems and in transpired water collected in plastic bags. Dye concentration was greatest in the upper part of the stems. As a tracer the dye offers a rapid method for studying the source, movement, and disposal of water used by phreatophytes. The method is rapid and inexpensive, and the laboratory determination is not difficult. The fluorometric determinations were made with a GK Turner Fluorometer Model III, which has a sensitivity of 1 ppb. (Knapp-USGS) W69-03047

#### THE EFFECT OF APPLIED INTERCEPTION ON TRANSPERSION RATES OF POTTED PONDEROSA PINE

Arizona Univ., Tucson. Dept. of Watershed Management.

David B. Thorud.

Water Resources Res, Vol 3, No 2, pp 443-450, 1967. 8 p, 2 fig, 2 tab, 11 ref.

Descriptors: \*Evapotranspiration, \*Transpiration, \*Interception, \*Ponderosa pine trees, Soil moisture, Winds, Humidity, Temperature.

Water was artificially applied to the foliage of small potted ponderosa pine trees to determine the effect of wetting on transpiration rates. By means of un-wetted control trees and a prediction equation, the hypothetical unwetted transpiration of wetted trees could be estimated. The difference between the estimated and actual transpiration was a measure of the transpiration reduction due to treatment. For 36 2 hr periods the average transpiration reduction was 14%, or 9% of the applied water. Thus, about 91% of the applied water was a net loss to soil moisture supplies. The saving as a percent of applied water varied from 4 to 14 and appeared to be weather related. Minimum values were generally observed on both cool, humid days and dry, hot, windy days. Higher savings were observed with more moderate weather. W69-03116

#### COLOR-INFRARED AERIAL PHOTOGRAPHIC INTERPRETATION AND NET PRIMARY PRODUCTIVITY OF A REGULARLY-FLOODED NORTH CAROLINA SALT MARSH

North Carolina State Univ., Raleigh. Dept. of Botany.

Linda M. Stroud, and Arthur W. Cooper.

North Carolina Water Resources Research Institute Report 14, November 1968. 86 p, 1 fig, 34 tab, 41 ref, 1 append. OWRR Project A-003-NC.

Descriptors: North Carolina, \*Salt marshes, Coastal marshes, Tidal marshes, \*Primary productivity, Biomass, \*Aerial photography, Remote sensing, \*Statistical models, Regression analysis, Photogrammetry.

Identifiers: Spartina alterniflora, \*Cordgrass, Juncus roemerianus, \*Black needlerush, Brunswick County (NC).

A study was made of net primary productivity of salt marsh communities in a 2000-acre, regularly flooded marsh in Brunswick County, N. C. Color infra-red aerial photographs were used to determine acreages of community types. Acreages were: short Spartina alterniflora (cordgrass) - 837; medium cordgrass - 195; tall cordgrass - 110; Juncus roemerianus (black needlerush) - 161; water - 474; other - 118. Net primary productivity estimates were based on harvest method data. Observed harvest data were fitted to a fourth degree polynomial in time in order to express the average behavior of the standing crop through the year. Net productivity was determined by two methods: (1) use of living standing crop only, and (2) use of changes in living and dead standing crop. Estimates of net primary productivity using changes in living and dead standing crops based on the prediction equation were: short cordgrass - 1106 kcal/m sq/yr; medium cordgrass 1856 kcal/m sq/yr; tall cordgrass - 6471 kcal/m sq/yr; black needlerush - 5346 kcal/m sq/yr. Over the entire marsh net primary productivity was estimated to be 1534 kcal/m sq/yr. These values were lower than similar values from Georgia but resembled closely other estimates of net primary productivity for salt marsh vascular plants in North Carolina. W69-03177

#### CORRELATING SOIL MOISTURE CONDITIONS AND MICROCLIMATE WITH EVAPORATION LOSSES AND WATER REQUIREMENTS OF PLANTS

South Dakota State Univ., Brookings.

For primary bibliographic entry see Field 02D.

For abstract, see .

W69-03198

## 2J. Erosion and Sedimentation

#### METHODOLOGICAL PREREQUISITES FOR CONDUCTING NETWORK OBSERVATIONS OF THE CHANNEL PROCESS

For primary bibliographic entry see Field 07A.

For abstract, see .  
W69-02807

#### BED FORMS IN THE LOWER RED DEER RIVER, ALBERTA

Research Council of Alberta, Edmonton.

C. R. Neill.

J Hydrol, Vol 7, (1969), No 1, pp 58-85, Nov 1968. 28 p, 12 fig, 3 tab, 16 ref.

Descriptors: \*Alluvial channels, \*Channel morphology, \*Bed load, \*Sand waves, Dunes, Flumes, Model studies, Discharge (Water), Sediment discharge, Streamflow.

Identifiers: Alberta (Canada), Red Deer River (Alberta), Streambed morphology.

Observations in the form of air photographs and echo soundings were made at various times over a period of 4 years on the Red Deer River near Duchess, Alberta. These revealed a complex system of both large- and small-scale features or wave forms on the sandy bed of the river. It is shown that the features, and with them the bed elevations at certain points, change considerably from time to time, and that minor forms in particular change size rapidly in response to changes in flow. The observations are discussed in terms of some recent efforts towards classification of riverbed forms and towards relating their properties to hydraulic factors. It is suggested that very detailed and extensive field observations would be needed to fully describe the bed topography and its changes at similar locations, and that laboratory observations of bed-forms in flumes do not in general reflect the extreme complexity of river situations. W69-02816

#### INTERRELATIONSHIP BETWEEN PHYSIOGRAPHY, HYDROLOGY, SEDIMENTATION, AND SALINIZATION OF THE LODDON RIVER PLAINS, AUSTRALIA

Geological Survey of Australia, Melbourne.

For primary bibliographic entry see Field 02B.

For abstract, see .  
W69-02817

#### USE OF THE COTTONWOOD IN AN INVESTIGATION OF THE RECENT HISTORY OF A FLOOD PLAIN

Johns Hopkins Univ., Baltimore, Md. Dept. of Geography.

Ben L. Everett.

Amer J Sci, Vol 266, pp 417-439, June 1968. 22 p, 9 fig, 2 plate, 14 ref.

Descriptors: \*Flood plains, \*Sedimentation rates, \*Sediment distribution, \*Dendrochronology, Ecological distribution, Cottonwoods, Alluvial channels, Geomorphology, Sediments, Deposition (Sediments), Alluvium, Ecology, North Dakota.

Identifiers: Little Missouri River, Flood plain development, Channel migration.

By examining the growth of the flood plain forest and its relation to the river, this study presents information on the origin of the sediments, time in transit, and the percentage of time the average sediment particle spends at rest in the flood plain deposits. Standard point measurements of sediment transport at gaging stations show only the amount of sediment being transported at a given time. In a 1-1/2 mi section of the Little Missouri River valley in western N. Dakota, data indicate that germination and growth of the cottonwood is intricately re-

## Field 02—WATER CYCLE

### Group 2J—Erosion and Sedimentation

lated to discharge of the river, movement of the channel, and flood-plain development. On the basis of age-area distribution of flood plain cottonwoods, a model has been constructed to describe channel migration and sediment transport. In the reach studied the river redistributes an average volume of sediments each century equal to the total available sediments in the valley by undercutting banks and depositing on point bars and flooded surfaces. Deposition on a unit of valley floor decreases exponentially with time owing to the progressive increase in elevation brought about by the deposition. Complex topography of the valley floor, including terrace-like forms and inset fills, may be explained entirely by modern processes presently at work in the valley. (Steinhilber-USGS)  
W69-02836

**THE CHEMISTRY OF LAKE SEDIMENTS FROM INDIAN TIBET.**  
Yale Univ., New Haven, Conn. Osborn Zoological Lab.  
For primary bibliographic entry see Field 02H.  
For abstract, see .  
W69-02960

**PROCESSES AND EXTENT OF EROSION AND ITS EFFECTS ON LAND USE IN THE CENTRAL LUNI BASIN, WESTERN RAJASTHAN.**  
Central Arid Zone Research Inst., Jodhpur (India).  
B. Ghose, S. Pandey, and S. Singh.  
Ann of Arid Zone, Vol 7, No 1, pp 15-30, March 1968. 16 p, 2 fig, 2 tab.

Descriptors: \*Soil erosion, \*Erosion control, \*Slopes, \*Water control, \*Wind erosion, Slope stabilization, Vegetation regrowth, Arid climates, Sands, Soil conservation, Surveys, Dunes, Gully erosion, Geomorphology, Aerial photography, Mapping.  
Identifiers: Rajasthan (India).

An erosion study was undertaken using the vertical aerial photographs of the Central Luni Basin of Western Rajasthan. With the use of photo-patterns, photo-interpretation and selected field surveys, maps were drawn up showing the erosion damage. Slope plays a significant role in water erosion only in the piedmont zones and hills. Water erosion was negligible in the Central Luni Basin. As a result of severe water erosion, which was confined to the (sand covered) piedmont zones and denuded surfaces, uncrossable gullies have been formed in the southeastern sector of the study area. Soil conservation measures like gully stabilization by revegetation, diversion channels and check dams could be used to lessen the soil erosion of this arid area. (Blecker-Arizona)  
W69-02987

**THE EFFECT OF SILT-LADEN WATER ON INFILTRATION IN ALLUVIAL CHANNELS,**  
William Gerald Matlock.  
Ph D dissertation, University of Arizona, 1965. 102 p, 34 fig, 12 tab, 52 ref.

Descriptors: \*Siltation, \*Infiltration, \*Alluvial channels, \*Flumes, \*Suspended load, Sediment load, Streambeds, Velocity, Arid lands, Arizona, Bed load, Channel flow, Variability, Permeability, Natural recharge, Flash floods, Correlation analysis, Groundwater recharge, Turbidity.  
Identifiers: Tilting-bed flume.

A tilting bed flume study was conducted at Tucson, Arizona to examine the relationships between velocity, suspended sediment and infiltration rate in alluvial channels for velocities from 2 to 5 feet per second and suspended sediment up to 0.6 percent. Bed materials from Rillito Creek were used in the flume experiments, which were made with constant velocity and variable suspended sediment and variable velocity. Samples from different locations along the creek bed showed considerable variability in mechanical analyses, permeability and infiltration tests, and suspended sediment content. A

direct relationship between velocity and infiltration rate and an inverse relationship between suspended sediment content and infiltration rate were found from the flume studies. A good correlation was obtained for flume results with the flow losses and natural recharge occurring in the river channels in the Tucson area. (Affleck-Arizona)  
W69-02988

#### RESEARCH ON BED-LOAD,

Institut za Vodoprivrednu, Jaroslav Cerni, Belgrade (Yugoslavia); and Belgrade Univ. (Yugoslavia). Vojislav Vukmirovic, and Slavoljub Jovanovic.  
Translation from Proc Institut za Vodoprivrednu 'Jaroslav Cerni' Vol 14, No 41-42, pp 137-147, 1967. TT67-58016.

Descriptors: \*Bed load, \*Stochastic processes, \*Statistical methods, Sampling, Particle size, Instrumentation, Tracers.  
Identifiers: Yugoslavia.

The work of the Jaroslav Cerni Institute of Yugoslavia in the study of bed load movement over the past 20 years is reviewed and discussed. A bibliography is included. Earlier work consisted of grain-size analysis of bank, bed, and moving sediment samples. More recently, electrical resistance probes were used to measure movement. Present work stresses radioactive tracer study of bed load movement and statistical study of the stochastic nature of particle movement. (Knapp-USGS)  
W69-03043

#### RUNOFF AND HILLSLOPE EROSION RESULTING FROM A HIGH-INTENSITY THUNDERSTORM NEAR MACK, WESTERN COLORADO,

Geological Survey, Denver, Colo.  
For primary bibliographic entry see Field 02A.  
For abstract, see .  
W69-03052

#### MEASUREMENT OF HYDRAULIC AND SEDIMENT TRANSPORT VARIABLES IN A SMALL RECIRCULATING FLUME,

Geological Survey, Fort Collins, Colo.  
R. E. Rathbun, and H. P. Guy.  
Water Resources Res, Vol 3, No 1, pp 107-122, 1967. 16 p, 4 fig, 6 tab, 9 ref.

Descriptors: \*Model studies, \*Hydraulic models, \*Flumes, \*Sediment transport, \*Research and development, \*Instrumentation, Depth, Velocity, Dunes

An evaluation of techniques for measuring the hydraulic and sediment transport variables in a small recirculating flume showed that (1) the average depth of flow over a ripple bed could be determined adequately by measuring the difference between the water-surface elevation and the sandbed elevation at a large number of positions and averaging the results; (2) the water-surface slope could be determined easily and accurately from a series of piezometers with taps positioned at 1-meter intervals along the flume center line; (3) the sediment transport rate was determined by passing all the water-sediment mixture through a trap covered with screen fine enough to hold the sand. The transport rate varied considerably (10-fold range) with respect to time. The following transport phenomena were noted: (1) there was no particle movement on the plane bed before ripple formation; (2) the mean velocity for cessation of particle movement (on the ripple bed) was about half that at which first movement occurred (on the plane and sand bed). (Knapp-USGS)  
W69-03056

#### SUSPENDED LOAD RESEARCH,

Institut za Vodoprivrednu Jaroslav Cerni, Belgrade (Yugoslavia). Vera Miloradov, and Branislav Dordevic.

Translation from Proc Institut za Poljoprivrednu 'Jaroslav Cerni' Vol 14 No 41, pp 177-191, 1967. TT-67-58016.

Descriptors: \*Suspended load, \*Sediment transport, \*Research facilities, Data collections, Reservoir silting, Density currents, Sampling, Hydraulic properties, Silting, Forecasting, Water structure.  
Identifiers: \*Yugoslavia, Hydrometeorological studies.

In Yugoslavia the first hydrometeorological stations for daily measurements of suspended load on the Danube, Sava, Tisa and Velika Morava Rivers began operation in 1957-1958. The work of the Jaroslav Cerni Institute in this field is reviewed and systematized and a bibliography presented. A description is given of equipment and methods used in field and laboratory, analyses to establish the load discharge balance at selected sites, special measurements and determination of water pattern and sediment movement under natural conditions, and studies of sedimentation in storage reservoirs and at river mouths. Research is being carried out for the needs of design of large water structures. (Lang-USGS)  
W69-03062

#### DESIGN OF STABLE CHANNELS IN ALLUVIAL MATERIALS,

Kansas State Univ., Manhattan; and Colorado State Univ., Fort Collins.  
For primary bibliographic entry see Field 08B.  
For abstract, see .  
W69-03066

#### DEPOSITIONAL BEHAVIOR OF KAOLINITE IN TURBULENT FLOW,

Massachusetts Inst. of Tech., Cambridge; and State Univ. of New York, Buffalo.  
Robert J. Etter, Richard P. Hoyer, and Emmanuel Partheniades.

ASCE Proc, J Hydraul Div, Vol 94, No Hy6, Pap 6242, pp 1439-1452, Nov 1968. 14 p, 12 fig, 12 ref.

Descriptors: \*Suspended load, \*Bed load, \*Kaolinite, \*Turbulent flow, \*Deposition (Sediments), Open channel flow, Sedimentation, Streams, Laboratory tests, Model studies.

An experimental investigation, utilizing an annular-rotating channel and a counterrotating ring, of the depositional characteristics of a fine, cohesive sediment revealed that after an initial period of rapid deposition, the sediment concentration approaches asymptotically an equilibrium value. Ratio of this equilibrium concentration to the initial concentration is nearly independent of initial concentration, and for given sediment properties and water chemistry, depends only on flow conditions. In the three water depths investigated, ratio was a single function of an average shear stress around the channel-section perimeter. A silty-clay sediment with a mean particle diameter of 0.0009 mm was used in all experiments. Comparison of size distributions of the parent material with the material retained in suspension when equilibrium was achieved indicated the greatest deposition occurs among the clay-size fractions, suggesting that the deposition is controlled predominantly by flocculation, and that strength and size of the flocs exert a stronger influence on deposition than does the initial particle weight. (Knapp-USGS)  
W69-03067

#### SEDIMENTATION IN THE PIRU CREEK WATERSHED SOUTHERN CALIFORNIA,

Geological Survey, Washington, D. C. Water Resources Div.  
Kevin M. Scott, John R. Ritter, and James M. Knott.  
U.S. Geol Surv Water-Supply Pap 1798-E, 1968. 48 p, 24 fig, 13 tab, 35 ref.

Descriptors: \*Sediment yield, \*Watersheds (Basins), Sediments, Analytical techniques, Regression analysis, Geomorphology, California.

Identifiers: Piru Creek, Transverse Ranges, Sediment-yield factors.

Methods used in estimating sediment yield of the Piru Creek watershed a tectonically active and physiographically diverse region in the Transverse Ranges, are presented and compared. The estimated yields determined by the various methods range from 165-303 acre-ft per yr. The probable sediment yield of the watershed above Pyramid Rock, site of a proposed reservoir, is 225 acre-ft per yr. This yield was determined by applying a basin-size correction to the yield of the entire basin, which was obtained by an adjusted sediment survey of a reservoir (Santa Felicia) near the mouth of the creek. The expectable maximum yield is believed to be about 504 acre-ft per year, which represents the amount of suspended sediment measured at the damsite during 1965, a year that included one of the most intense storm periods in Southern California history. Analyses and correlations of sediment yield in other basins of the Transverse Ranges are discussed. Also, the factors affecting erosion and sediment yield, such as regional climatic parameters, effective precipitation, precipitation intensity, soil erodibility, drainage area, physiographic parameters, and land-use, are discussed and evaluated. Equations relating these factors and regression analyses used in correlation procedures are presented. (Steinhilber-USGS)  
W69-03084

**WATER AND SEDIMENT IN THE NORRIS GLACIER OUTWASH AREA, UPPER TAKU INLET, SOUTHEASTERN ALASKA,**  
Alaska Univ., College. Inst. of Water Resources.  
Roger M. Slatt, and Charles M. Hoskin.  
*J of Sediment Petrol*, Vol 38, No 2, pp 434-456, June 1968. 23 p, 19 fig, 3 tab, 51 ref. OWRR: A-008-ALAS.

Descriptors: \*Alluvium, \*Glacial drift, \*Melt water, \*Estuaries, Alaska, Particle size, Particle shape, Permeability, Salinity, Saline water intrusion, Aquifers.  
Identifiers: Alluvial fans, Taku Inlet (Alaska).

A study was made of the sediments and hydrology of an alluvial fan extending from the terminus of Norris Glacier to upper Taku Inlet, southeastern Alaska. The tidal flat is composed of poorly sorted muddy sediment and relatively well sorted sand overlying outwash gravel. The sand-size fraction contains feldspar, quartz, rock fragments, amphiboles, pyroxenes, micas, and opaque minerals, and the clay-size fraction contains micas, chlorite, montmorillonite, feldspar, and amphibole. The sediments consist of abrasion products of glaciers in the Juneau Ice Field. Absence of quartz and presence of feldspar in the clay-size fraction may indicate the limits of size to which the various minerals are abraded by valley glaciers. Permeability and salinity measurements show that water in the outwash is always fresh although the deposit is covered by salt water at high tide. The outwash apparently carries a large enough flow of melt water with higher head than the high tide level, preventing intrusion of salt water or flushing out any intruded salt water. (Knapp-USGS)  
W69-03093

**SIMILITUDE THEORY APPLIED TO CORRELATION OF FLUME SEDIMENT TRANSPORT DATA,**  
Strathclyde Univ., Glasgow (Scotland). Dept. of Civil Engineering.  
David I. H. Barr, and John G. Herbertson.  
*Water Resources Res*, Vol 4, No 2, pp 307-315, April 1968. 9 p, 4 fig, 2 tab, 16 ref.

Descriptors: \*Sediment transport, \*Correlation analysis, Synthesis, Sediments, Data processing, Analytical techniques, Hydraulics, Flumes.  
Identifiers: Similitude theory.

A second variant of the method of synthesis, the method of linear proportionality, is presented and shown to be a powerful device for seeking correla-

tion procedures for sediment transportation data. It is apparent that correlations for sediment transportation data under conditions of quasi-uniform flow are of the same basic form as those for rough pipe flow, with some amplification for practical reasons. Certain established correlations are shown to be based on similarity equations from which parametric terms have been omitted, mostly without justification. A rigorous method of correlation compatible with feasible laboratory procedures is presented and illustrated in figure form using available data. It was found that the bulk of the published data was in a form unsuitable for use in a rational correlation. The authors conclude that new experimentation is required and that this could best be done by cooperation among institutions with the necessary apparatus.  
W69-03095

**HYDRAULIC AND MICROMORPHOLOGICAL PROPERTIES OF STREAM CHANNEL SEDIMENTS,**  
Arizona Univ., Tucson; and North Carolina State Univ., Raleigh.  
H. K. Qashu, and S. W. Buol.  
*Water Resources Res*, Vol 3, No 2, pp 465-469, 1967. 5 p, 3 fig, 1 tab, 4 ref.

Descriptors: \*Alluvium, \*Alluvial channels, \*Clays, \*Silts, \*Hydraulic conductivity, \*Infiltration, Permeability, Porosity, Aggregates, Mixing.  
Identifiers: \*Micromorphological properties.

In the arid and semiarid regions of the southwestern United States, a large portion of the natural water recharge is through channel beds and alluvial deposits in river basins. Water transmission in these beds varies with time, location, depth and extent of alluvium, and hydraulic characteristics of flows, sediment loads, and morphology of the channels. An alluvial profile in an ephemeral stream channel was found to have layers with relatively high clay and silt accumulation. Samples from a pit in the channel were subjected to a micromorphological examination using thin sections. Clay and silt were found to have accumulated on sand and gravel particles and around aggregates. In the laboratory, samples of alluvium material were dispersed. The clay and silt fractions were collected, dried, and then mixed again with the washed material. The hydraulic conductivity of the mixed material was 30% less than that for the non-dispersed sample. These results are attributed to the orderly arrangement of clay and silt on the surfaces and between the larger sand and gravel particles of the nondispersed samples.  
W69-03108

**SEDIMENT SURVEYS IN CANADA,**  
Department of Energy, Mines and Resources, Ottawa (Ontario). Inland Waters Branch.  
W. Stichling, and T. F. Smith.  
*Tech Bull* 12, 1968. 17 p, 14 fig, 1 tab.

Descriptors: \*Sediment transport, \*Geomorphology, Sediments, Reservoirs, Bed load, Suspended load, Particle size, Sampling, Equipment.  
Identifiers: Sediment survey, Canada.

An outline of sediment surveys in Canada, including a brief history of sediment surveys, current status of the program, and future plans is presented. Prior to 1961, measurements of suspended sediments were undertaken by individual organizations and agencies at a few specific-purpose sites. A continuous sediment survey program was initiated in 1961 in response to the growing demands for sediment data by water management. By January 1968, the Water Survey of Canada was operating 77 stations. The techniques and instrumentation used in collecting data at these stations are discussed. Plans for the future call for expansion of the network during the next 5-10 yr to 300 sediment stations to cover all areas in the country in which streams are affected by sediment processes. The future program includes analyses of the sediment data for special

geomorphological studies of the major river channels and reservoirs. (Steinhilber-USGS)  
W69-03123

## 2K. Chemical Processes

**TRACER MEASUREMENT OF STREAM REAERATION. II. FIELD STUDIES,**  
Georgia Inst. of Tech., Atlanta; Arctic Health Research Center, Fairbanks, Alaska; and Southwestern Radiological Health Lab., Las Vegas, Nev.

For primary bibliographic entry see Field 02E.  
For abstract, see .  
W69-02821

**GRAPHICAL METHODS FOR STUDIES OF AQUEOUS ALUMINUM HYDROXIDE, FLUORIDE, AND SULFATE COMPLEXES,**  
Geological Survey, Washington, D.C.

For primary bibliographic entry see Field 01B.  
For abstract, see .  
W69-02834

**UNITED STATES TRITIUM RAINOUT AND ITS HYDROLOGIC IMPLICATIONS,**  
Geological Survey, Washington, D. C.  
For primary bibliographic entry see Field 02B.  
For abstract, see .  
W69-03121

## 2L. Estuaries

**A MODEL OF MIXING AND DISPERSION IN SAN FRANCISCO BAY,**  
California Univ., Berkeley.

For primary bibliographic entry see Field 05B.  
For abstract, see .  
W69-02831

**SOME HYDROLOGICAL OBSERVATIONS IN AUCKLAND AND OTAGO HARBOURS,**  
Auckland Univ. (New Zealand); and Marine Biological Station, Port Erin, Isle of Man (England).

D. J. Slinn.  
*Trans Royal Soc of New Zealand (General)*, Vol 2, No 5, pp 79-97, Jan 1968. 19 p, 11 tab, 7 fig, 32 ref.

Descriptors: \*Tidal waters, \*Harbors, \*Saline water, Intertidal areas, Water quality, Coasts, Nutrients, Oxygen, Salinity, Temperature.  
Identifiers: New Zealand, Auckland, Otago, Hydrological observations, Tidal water quality.

Data on monthly means of temperature, salinity, oxygen, and nutrients (nitrate, nitrite, phosphate, and silicate) are presented for Auckland and Otago Harbors during 1963. Some data from other years are used, however little information was collected prior to 1963 for the coastal waters of New Zealand. Sea surface temperatures are compared with local air temperatures, and salinity with rainfall. In both harbors, fresh water influence is small in summer, but more noticeable in winter. Generally, nutrients are low in summer and high in winter, although phosphate does not appear to have a well defined pattern. There seems to be little chemical evidence of organic pollution in either harbor. Conclusions presented are that Auckland Harbor is vertically well-mixed as a result of tidal currents; this may apply to Otago Harbor as well. (Steinhilber-USGS)  
W69-02835

**ACCURACY OF DISCRETE MODELS USED TO PREDICT ESTUARY POLLUTION,**  
Rice Univ., Houston, Tex.

For primary bibliographic entry see Field 05B.  
For abstract, see .  
W69-03107

# WATER SUPPLY AUGMENTATION AND CONSERVATION

## Group 3A—Saline Water Conversion

### 03. WATER SUPPLY AUGMENTATION AND CONSERVATION

#### 3A. Saline Water Conversion

##### OPTIMIZATION AND RANGE OF APPLICATION OF NUCLEAR REACTORS AND FLASH EVAPORATORS FOR SEA WATER DESALINATION,

Technion-Israel Inst. of Tech., Haifa.

F. S. Aschner, S. Yiftah, and P. Glueckstern. Desalination, Vol 3, No 1, pp 82-90, 1967. 9 p, 4 fig, 1 tab, 3 ref.

Descriptors: \*Desalination plants, \*Mathematical models, \*Optimization, Dual purpose, Technical feasibility, Economic efficiency, Electric power production, Water supply, Nuclear reactors, Flash distillation, Water costs.

Identifiers: Israel.

Desalination plants were defined by mathematical models and optimized technically and economically. The research dealt with nuclear reactors, and for comparison with conventional boilers, as heat sources for dual- and single-purpose plants. The distillation plants considered were of the multi-stage flash evaporator type. The dual-purpose plant research covered a range from 50 MW to 300 MW net power generation, and 10 to 200 mgpd water production. The single-purpose plant investigation covered the thermal ratings in the range from 200-1600 MWt corresponding to the same range of water output as the dual-purpose plants. Optimum water costs were tabulated. The influence of the water cost of turbine exhaust temperature and of economic parameters, such as fixed charge rate and electricity value was also analyzed. (Gysi-Cornell)

W69-03147

#### 3B. Water Yield Improvement

##### USE OF MONOMOLECULAR FILMS TO REDUCE EVAPORATION FROM THE SURFACE OF BODIES OF WATER,

V. F. Pushkarev, and G. P. Levchenko.

Translated from Trudy Gos Gidrol Inst, No 142, pp 84-107, 1967. Soviet Hydrol Selec Pap (AGU), No 3, pp 253-272, 1967. 20 p, 5 fig, 5 tab, 13 ref.

Descriptors: \*Evaporation control, \*Monomolecular films, Alcohols, Hexadecanol, Byproducts, Organic acids, Water conservation, Lakes, Ponds.

Identifiers: \*USSR, Aliphatic acid-manufacturing byproducts.

The results of experimental investigations of monomolecular films as evaporation depressants by the USSR State Hydrological Institute are summarized and recommendations are made for their use and for methods to determine both their physical and cost effectiveness. More than 120 types of alcohols were tested. Secondary unsaponifiable substances formed as byproducts of synthetic aliphatic acids are being produced in large quantities and are the most available and inexpensive alcohols. They have evaporation-retarding properties as good as those of alcohols obtained from natural fats and oils. Devices for monolayer application are described. Alcohol is delivered to the water surface at a rate proportional to wind velocity. (Knapp-USGS)

W69-02805

EFFECTS OF A MONOLAYER ON RESERVOIR TEMPERATURE AND EVAPORATION, Army Electronics Command, Fort Huachuca, Ariz. Atmospheric Sciences Laboratory; and Texas A and M Univ., College Station. Jon F. Bartholic, Jack R. Runkles, and Ernest B. Stenmark.

Water Resources Res, Vol 3, No 1, pp 173-179, 1967. 7 p, 3 fig, 1 tab, 12 ref.

Descriptors: \*Evaporation control, \*Monomolecular films, \*Temperature, Heat budget.

Data collected specifically to evaluate the increase in the water temperature in a reservoir due to the presence of a monolayer showed an increase in temperature not only at the surface but also at greater depths. This increase in temperature must be accounted for in predicting the reduction in evaporation by monolayers. Use of values for the increase in temperature predicted from the combined energy-budget mass-transfer method indicates a decrease of 8 to 14% in values for evaporation reduction as estimated by the simplified Bureau of Reclamation method, which does not account for the rise in temperature. An approach to predicting the increase in reservoir temperature and the reduction in evaporation as applied to one reservoir gave values for the temperature increase close to those measured. (Knapp-USGS)

W69-03054

##### GROUND-WATER OCCURRENCE AND STRATIGRAPHY OF UNCONSOLIDATED DEPOSITS, CENTRAL PIERCE COUNTY, WASHINGTON,

Department of Water Resources, Olympia, Wash.

For primary bibliographic entry see Field 02F.

For abstract, see .

W69-03081

#### 3E. Conservation in Industry

##### RECLAIMED WATER FOR INDUSTRY, T. H. V. Tebbutt.

Effl and Water Treat J, Vol 7, pp 587-593, 1967. 7 p.

Descriptors: \*Water utilization, \*Waste water treatment, \*Beneficial use, \*Water reuse, Industrial water, Potable water, Sewage effluents, Management, Water quality, Water conservation.

Identifiers: \*Reclaimed water.

Summary information is given of the potential use of reclaimed waste water from industry and the possibilities for thus increasing the supply of potable water in many places. Water for cooling is the largest use, with steam generation, process needs, and potable water in that order. Re-cycling and utilization of sewage effluent and other good management procedures are suggested as methods of reducing water demand. To prevent growth of micro-organisms, chlorination of sewage water may be necessary but the cost of such treatment is less than half that of using potable water. Reclaimed waste water would be of better chemical quality than most available river or canal waters. Various processes for contaminant removal are presented. Studies in progress to prevent eutrophication of Lake Tahoe by sewage effluent and the production of good-quality water from industrial effluent at a plant in SW Africa are described. (Lang-USGS)

W69-02806

#### 3F. Conservation in Agriculture

##### INVESTIGATIONS ON THE IRRIGATION REQUIREMENTS OF HYBRID MAIZE CROP IN ARID REGION OF PUNJAB, Punjab Agricultural Univ., Hissar (India). Dept. of Agronomy.

M. K. Moolani, and N. K. Behl.

Ann of Arid Zone, Vol 7, No 1, pp 105-115, March 1968. 11 p, 2 fig, 7 tab, 18 ref.

Descriptors: Irrigation effects, \*Water requirements, \*Consumptive use, Fertilizers, \*Arid lands, \*Nitrogen, Crop response, Irrigation efficiency, \*Corn (Field), Field capacity, Soil moisture, Depth, Seasonal, Soil-water-plant relationships.

Identifiers: Hybrid maize.

A field experiment was conducted at the Agronomy Research Farm, Punjab Agricultural University.

Hissar, India, to determine the effects of different levels of irrigation, nitrogen and plant density on the yield of hybrid maize. Consumptive uses seasonal water requirements and irrigation requirements of maize were found to vary from 45-53 cm, 52-72 cm, and 20-40 cm, respectively under various treatments. These values were found to be highest in maximum delta of irrigation. Irrigation efficiency ranged from 70-81%. The crop used the maximum amount of available moisture (50%) from the upper 30cm soil layer and the rest of the available moisture was made up from the lower soil layers. (Blecker-Arizona)

W69-02973

##### SPRINKLER AND SURFACE IRRIGATION OF VEGETABLE AND FIELD CROPS IN AN ARID ENVIRONMENT,

California Univ., Berkeley.

F. E. Robinson, O. D. McCoy, G. F. Worker Jr., and W. F. Lehman.

Agron J, Vol 60, No 6, pp 696-700, Nov-Dec 1968. 5 p, 10 tab.

Descriptors: Arid climates, Crop response, \*Irrigation effects, \*Sprinkler irrigation, \*Surface irrigation, \*Field crops, \*Vegetable crops, Rates of application, Plant growth, Leaching, Irrigation efficiency, Deserts, Application methods, Water utilization, Furrow irrigation, Saline soils, Flood irrigation, Soil texture.

Identifiers: Imperial Valley (California), Dry matter.

Four experiments were conducted in the Imperial Valley of California to investigate the effects of sprinkler irrigation on a number of different crops, and to obtain comparisons of emergence, growth, and soil characteristics under surface and sprinkler irrigation. In addition, modification of conventional bed shapes to improve land utilization efficiency under sprinkler irrigation were explored. The experiments were conducted on clay and sandy clay loam soils. Emergence and early growth rates of five field crops were equal or better under sprinkling in the clay soil. Early growth rates of 10 vegetable crops were equal or greater under sprinklers on the sandy clay loam. Final yields indicated the sprinkler irrigation would require more frequent applications than the surface systems, however, sprinkler irrigation was shown to have a higher water use efficiency than the surface systems. (Affleck-Arizona)

W69-02974

##### SOIL WATER FLUX BELOW A RYEGRASS ROOT ZONE,

California Univ., Davis.

For primary bibliographic entry see Field 02G.

For abstract, see .

W69-02975

##### FURROW SIZE, PLACEMENT, AND GRASS CULTURE EFFECTS ON VINEYARD IRRIGATION,

California Univ., Davis. Department of Water Science and Engineering; and Calif. Univ., Davis. Agricultural Extension Service.

P. Christensen, L. Doneen, L. Werensels, and C. Houston.

Calif Agr, Vol 22, No 6, pp 10-12, June 1968. 3 p, 7 fig.

Descriptors: \*Irrigation water, Turf grasses, Furrow systems, \*Furrows, \*Grassed waterways, Irrigation efficiency, Cultivation, California, \*Percolation, Infiltration, Flow measurement.

Identifiers: \*Vineyard irrigation, Undervine furrows.

Studies were conducted in Fresno County, California to evaluate irrigation water penetration rates as affected by size and placement of furrows and the use of grass culture. The test plots were established in a 30-year-old vineyard on a Dinuba fine sandy loam soil and included (1) flat furrows with clean

## Control of Water on the Surface—Group 4A

cultivation; (2) flat furrows with grass culture; (3) a wide middle-row basin with clean cultivation; (4) a wide middle-row basin with clean grass culture; and (5) a wide furrow under the vine row. The undervine furrows showed excellent water penetration as compared to the other four methods. The grass culture nearly doubled the water intake rate in the furrows and basins from mid-summer on, (presumably after a sod-condition developed). (Afleck-Arizona)  
W69-02978

**ANTI-TRANSPIRANTS AS A RESEARCH TOOL FOR THE STUDY OF THE EFFECTS OF WATER STRESS ON PLANT BEHAVIOUR,**  
Hebrew Univ., Jerusalem (Israel). Dept. of Botany.  
J. Gale, and A. Poljakoff-Mayber.  
Unesco Arid Zone Research, Vol 25, pp 269-274,  
1965. 6 p, 5 fig, 1 tab.

Descriptors: \*Transpiration control, Water conservation, \*Stomata, \*Moisture deficit, \*Moisture stress, Turgidity, Water balance, Plant physiology, Plant growth, \*Retardants, Wilting point, Weight, Sprays, Films, Arid lands, Diurnal.  
Identifiers: Israel.

One aspect of the study of anti-transpirants is their direct and indirect effect on plant water stress. Evidence that anti-transpirant sprays actually decrease plant water stress has been obtained from experiments in which stomata of treated plants have been found to remain open wider and for longer periods than those of non-treated plants. Increased relative turgidity of treated plants is additional evidence of the direct effect of anti-transpirants on the water balance of plants. Anti-transpirants have been shown to modify growth and development of plants in the field in a manner which closely resembles the effect of reduced moisture stress obtained by irrigation. In addition to their potentialities as reducers of irrigation water expenditure in arid climates, anti-transpirants may prove to be a versatile research tool for water stress studies if their numerous side effects are taken into account. (Blecker-Arizona)  
W69-02986

**PONTACYL BRILLIANT PINK AS A TRACER DYE IN THE MOVEMENT OF WATER IN PHREATOPHYTES,**  
Geological Survey, Menlo Park, Calif.  
For primary bibliographic entry see Field 02I.  
For abstract, see .  
W69-03047

**AN ANALYSIS OF TEMPERATURE BEHAVIOR IN IRRIGATED SOIL PROFILES,**  
California Univ., Davis. Department of Water Science and Engineering.  
For primary bibliographic entry see Field 02G.  
For abstract, see .  
W69-03053

**PROJECTION OF AGRICULTURAL WATER AND LAND USE FOR LONG RANGE WATER RESOURCES IN TEXAS,**  
Texas A and M Univ., College Station.  
Fred A. Schmer, and Glen L. Wistrand.  
Proceedings of the Third Annual American Water Resources Conference (American Water Resources Assn; Urbana, Ill), c 1967, pp 405-413.  
9 p, 1 fig, 1 chart, 1 ref.

Descriptors: \*Agriculture, Irrigated land, Land use, Water supply, Water resource development, Texas, Planning, Future planning, Model studies, Land.

Four models of resource use and commodity output illustrate the probable effects of alternative water supply situations in Texas. Model A represents Texas' physical potential for agricultural production if unlimited water supplies existed while Model B is tempered by the inclusion of economic limitations on the irrigated production of some

commodities and production goal limitations for the state. Model D is realistic within the limits imposed by the assumptions made about prices, factor proportions and cropping patterns. It suggests the development which we can expect in Texas in terms of projected water availability, crop yields, land use and producers' competitive positions in national markets. Model D suggests what might happen if we do little or nothing in the way of water resource development. These models are useful in water resource planning. (Winn-Rutgers)  
W69-03144

**DRAINAGE THEORY FOR REMOVAL OF EXCESS WATER FROM IRRIGATED LANDS,**  
Washington State Univ., Pullman. Dept. of Agricultural Engineering.  
For primary bibliographic entry see Field 04A.  
For abstract, see .  
W69-03189

## 04. WATER QUANTITY MANAGEMENT AND CONTROL

### 4A. Control of Water on THE Surface

#### EICKSTEDT V SEIFERT (NEGLIGENCE IN DRAINING ARTIFICIAL RESERVOIR).

273 Wisc 122, 76 NW 2d 582-585 (1956).

Descriptors: \*Wisconsin, \*Drainage effects, \*Pumping, \*Reservoirs, Judicial decisions, Drainage systems, Water conveyance, Ditches, Drainage water, Percolation, Percolating water, Underseepage, Subsurface drainage, Tile drains, Outlets, Legal aspects, Highways, Crops, Damages.  
Identifiers: Negligence, Crop damage.

Plaintiffs produced truck crops on land located across a highway from land of defendant. Several years prior to this action, defendant Seifert excavated a large pit, thus creating an artificial reservoir. Seifert contracted to sell gravel from the pit bottom to the co-defendant, Ozaukee County. Plans were made to pump the water from the pit into an established drainage ditch along defendant's side of the highway. Plaintiff, before the pumping began, asked the defendants to place the pump outlets in such a way as to avoid drainage onto plaintiff's land and to use tile drains. The defendants ignored plaintiff's warnings and requests and proceeded to drain the pit as originally planned. The ditch was unable to adequately carry away the large volume, and water percolated underneath the highway onto plaintiff's land causing crop damage. Plaintiff's claim for damages was dismissed by the lower court for failure to state a cause of action. The Supreme Court reversed and remanded for a jury trial on issue of negligence. Court found it to be immaterial whether the damage resulted from waters directly overflowing the surface or from waters reaching the lands through percolation. (Wheeler-Fla)  
W69-02856

#### CRAIG V BOROUGH OF EBENSBURG (DAMS).

137 A 2d 886-890 (Super Ct Pa 1958).

Descriptors: Judicial decisions, Legal aspects, \*Pennsylvania, Cities, Flood damage, \*Dams, Diversion structures, Personnel, Obstruction to flow, Floods, Dam construction, Dam Design.

Defendant's employees constructed flashboards on the spillway of a dam of which it had assumed responsibility from the Commonwealth of Pennsylvania. The flashboards caused the water to back up and flood plaintiff's land. Before the construction of the flashboards, Plaintiff had called attention to

the fact that his land might be flooded if the construction was performed. The defendant erected the flashboards, and, thus, it was held liable notwithstanding the fact that the specifications were prepared and the work was done under supervision of the Commonwealth of Pennsylvania. (Molica-Fla)  
W69-02859

#### ANDERSON V ARGRAVES (RECOVERY AGAINST STATE FOR NEGLIGENT WATER COURSE CONSTRUCTION).

20 Conn Super 138, 127 A 2d 620-624 (Super Ct Conn 1956).

Descriptors: Judicial decisions, Connecticut, Controlled drainage, Drainage effects, Floodwater, Flood routing, Flood protection, Watercourses (Legal), Storm runoff, Streams, Damages, Bridge Design, Culverts, Roads, Drains, Operation and maintenance, Highways, Rain water.  
Identifiers: Negligence, Debris.

Plaintiff, a non-adjacent landowner to highway and culvert constructed by the state, sought damages for negligent construction and maintenance of the road and culvert. During a heavy rainstorm, the culvert became clogged with debris and subsequently burst open, causing damage to plaintiff's downstream property. Plaintiff claimed the culvert was too narrow to safely accommodate the normal amount of water. Plaintiff relied on three Conn statutes, in attempting to circumvent the problem of governmental immunity. (These were Conn gen stat secs 2134, 2194, 2201.) Sec 2134 authorized the state to construct water course drainage for highway purposes into or on private land and provided relief for unnecessary damage resulting therefrom. Defendant did not drain water onto, or open any water course on, plaintiff's land; consequently, section 2134, was inapplicable. Unnecessary damage was all that section 2194 protected against. Plaintiff failed to show the damage caused was unnecessary since storm complained of caused unprecedent damage in many parts of the state. Section 2201 authorized recovery for damages caused by defective highways, but only for persons on the highway for some legitimate purpose connected with travel thereon. It provided no right of recovery for an abutting landowner, much less a non-abutting landowner. (Holt-Fla)  
W69-02862

#### ATLANTIC CRUSHED COKE CO V UNITED STATES (FLOOD DAMAGE).

151 F Supp 317-322 (Ct Cl 1957).

Descriptors: Judicial decisions, Legal aspects, Pennsylvania, \*Federal governments, \*Eminent domain, Coal mines, Flood damage, \*Water injury, Flooding, Dams, Backwater, Ponding, Mine water, Compensation.  
Identifiers: Inverse condemnation.

Defendant constructed a dam which would periodically cause waters to back up into the coal mines adjacent to the mine of plaintiff. The Secretary of Mines issued an order prohibiting the plaintiff from mining because the barrier between his mine and those adjacent to it was not sufficient to withstand the expected water pressure. Defendant was not liable for the loss of use of plaintiff's mine, because such loss was not the natural and necessary consequence of the erection of the dam. Defendant was not held to have known that the barrier between plaintiff's mine and those adjacent to it was insufficient to keep plaintiff's mine from flooding. Plaintiff did not make a bona fide effort to enter into an agreement with the defendant to make it possible to operate its mine, and did not appeal the order, which was its right under statute. Therefore, there was no basis for plaintiff's plea for compensation for a taking by eminent domain. (Molica-Fla)  
W69-02864

## Field 04—WATER QUANTITY MANAGEMENT AND CONTROL

### Group 4A—Control of Water on the Surface

#### HUTHER V UNITED STATES (DAMAGE CLAIM DUE TO RISING LAKE WATERS).

145 F Supp 916-919 (Ct Cl 1956).

Descriptors: \*United States, \*Lake Ontario, \*Dam construction, \*Eminent domain, Judicial decisions, St Lawrence River, Dams, Contracts, Federal government, Backwater, Damages, High water mark, Legal aspects, Operation + maintenance, Navigable waters, Compensation.

Identifiers: Canadian government.

Congress gave its consent for Canada to construct a dam which would cross or abut territory of the United States. It was expressly stated that the construction would not materially affect the water level of Lake Ontario or the Saint Lawrence River, or cause any injury to the United States, or its citizens. Following construction, rising lake waters allegedly caused damage to United States citizens owing property on the lake shore. These persons brought suit against the United States. The Court of Claims granted a motion to dismiss. The Court reasoned that the United States had no part in the construction and that an action for taking property without compensation would not lie since there was no taking of property by the United States for public use. The court suggested that claim should be made against the Canadian government, through Canadian courts. (Wheeler-Fla)

W69-02865

#### GEIS V ROHRER (RIGHT OF NATURAL DRAINAGE).

145 N E 2d 596-599 (Ill 1957).

Descriptors: \*Illinois, Judicial decision, \*Relative rights, Surface runoff, Farm management, Drainage systems, \*Drainage, Outlets, Culverts, Water conveyance, Ditches, \*Natural flow, Easements, Obstruction to flow, Land fills, Water courses (Legal).

Plaintiffs owned farm land located above lands of the defendants. For many years, water flowed from plaintiff's land, through a culvert, into a waterway upon defendant's land, and out a lower culvert. Defendants' farming operations caused a filling of the waterway sufficient to impede the prior natural drainage. Plaintiffs brought suit for injunctive relief, praying that the obstruction be removed and defendants be restrained from further interference with the natural drainage. The lower court granted the injunction and gave the higher landowners a perpetual easement to enter defendant's land and to insure that the waterway was kept open. The Supreme Court affirmed the injunction but disallowed the easement. The Court held that the lower landowner owed a duty not to interfere with the natural drainage, but that it was not necessary, in order to protect the rights of the parties, to grant the easement. (Wheeler-Fla)

W69-02877

#### LOMBARDI V BAILEY (SUIT FOR FLOOD DAMAGES UNDER MILL ACT).

147 N E 2d 169-175 (Mass 1957).

Descriptors: \*Massachusetts, Judicial decisions, \*Flood damage, \*Dams, Overflow, Reservoirs, Water injury, Floods, Damages, Legal aspects, Legislation.

Identifiers: \*Mill acts, Measure of damages.

Petitioners brought suit under the Massachusetts Mill Act to recover for damage to their lands from flooding caused by respondents' dam. Respondents had built a dam across a brook for the purpose of flooding their cranberry bogs. However, the water overflowed onto petitioners' lands, making them unsuitable for agricultural purposes. The case was referred to an auditor for final findings of fact. The major issue on appeal was the action of the auditor. However, the Supreme Judicial Court did state that the purpose of the Mill Act was to substitute a more simple and expeditious remedy for flooding than

was available at common law. The measure of damages is the diminution in rental value of the land during the period of the injury. The period of limitations begins to run at the date of the first injury from the water, not the date of completion of the dam. (Williams-Fla)

W69-02878

#### SENCO V LACROSSE DREDGING CORP (DEFINITION OF NAVIGABLE WATERS).

16 Ill App 2d 154, 147 N E 2d 708-711 (1957).

Descriptors: \*Illinois, Federal government, Mississippi River, \*Navigable waters, \*Dredging, Judicial decisions, Legislation, Rivers, Navigation, Accidents, Damages, Legal aspects, Backwater.

Plaintiff had sued his employer under the Jones Act for injuries he received on land during a dredging operation. The dredging was taking place in some backwaters of the Mississippi River, and, on remand one of the issues was whether these constituted navigable waters. The court held that 'navigable waters of the United States' meant bodies of water which were used, or susceptible of being used, in their ordinary condition or with reasonable improvements, as a highway for commerce. Such bodies of water do not have to actually be used for commerce, and the fact that artificial aids are necessary to make possible their commercial use does not necessarily make them nonnavigable. Once a waterway is found to be navigable, it retains that character. (Williams-Fla)

W69-02879

#### NAYLOR V EAGLE (DAMAGE FROM BACKWATER OF DAM).

303 SW 2d 239-242 (Ark 1957).

Descriptors: \*Arkansas, Judicial decisions, Damages, Flood damage, \*Dams, Backwater, \*Overflow, Dams, Flow control, Water injury, Non-navigable waters, Alteration of flow, Obstruction of flow, Relative rights, \*Riparian land, River flow, Riparian rights, Legal aspects.

Identifiers: Injunction.

In a suit for damages and a mandatory injunction the plaintiff alleged that overflow backwaters from the defendant's dam injured his farmland, making cultivation impossible. The defendant denied the allegations and further contended that the suit was barred by three year statute of limitations. The plaintiff appealed from the chancellor's finding for the defendant. The Supreme Court held that although the suit was filed more than three years after the dam's construction, the statute of limitations had not run. If damage to land above a dam is only probable upon the construction of the dam, and the certainty and extent of such damage is only speculative, the statute will begin to run only when injury occurs. In such a situation there may be as many successive recoveries as there are injuries. A riparian owner along a nonnavigable stream has no right to upset the natural flow of a stream to the detriment or damage of other riparian owners. However, the court held in affirming the chancellor's decision that the finding was not against the preponderance of the evidence even though there was expert testimony contrary to the finding. (Blunt-Fla)

W69-02883

#### WOLFF V LOUISVILLE WATER CO (DENIAL OF WATER MAIN EXTENSION REQUEST).

302 SW 2d 104-105 (Ct App Ky 1957).

Descriptors: \*Kentucky, Judicial decisions, Water distribution (Applied), Pipelines, \*Public utilities, Water demand, Water delivery, \*Water allocation (Policy), Administrative decisions, Local governments.

The plaintiff sought a court order directing the defendant water company to extend its main to his property. The water company refused to extend the main unless the plaintiff agreed to pay the cost of the extension. This amount would be repaid if the net revenue to the company from the user amounted to 15% of the adjusted cost of line in the 12 months following the extension. The circuit court granted the company's motion for summary judgment and the plaintiff appealed. In affirming the judgment this court noted that the defendant water company was an operating facility of the City of Louisville. The city itself was therefore engaged in the business of furnishing water to its inhabitants. Since the company was governmentally controlled it must be granted governmental discretion in devising reasonable regulations for operating the company. Where, as here, such regulations are deemed reasonable and the agents of the water company exercise reasonable discretion in refusing a request to extend a main without the party requesting the service paying the actual cost, the company could not be made to extend the main under the compulsion of a mandatory court order. (Blunt-Fla)

W69-02884

#### FERGUSON V UNION ELECTRIC COMPANY (SUIT FOR DAMAGES CAUSED BY IMPROPER OPERATION OF A DAM).

305 S W 2d 401-407 (Mo 1957).

Descriptors: \*Missouri, Judicial decisions, Public utilities, Damages, Dams, Sedimentation, Flood waters, \*Overflow, \*Obstruction to flow, Floodgates, Water level fluctuations, \*Reservoir silting, Operation and maintenance, Legal aspects, Lakes.

Plaintiffs sued to recover for damage to their crops caused by flood waters. It was alleged that a dam operated and constructed by defendant formed a lake which caused silt to be deposited in the sloughs and river beds so as to cause the flood water to rise higher than it normally would. Defendant negligently failed to open the floodgates at the dam and permitted the water in the lake to rise above the 660 foot elevation considered normal for a full reservoir. It was alleged that the silt and high water level retarded the flow of floodwater and caused the damage. The court found that the evidence supported the allegations and was sufficient for the jury to find for plaintiffs. (Childs-Fla)

#### CURTIS V LOUISVILLE AND JEFFERSON COUNTY METROPOLITAN SEWER DISTRICT (ASSESSMENT FOR DRAINAGE IMPROVEMENT).

311 S W 2d 378-384 (Ky Ct App 1958).

Descriptors: \*Kentucky, Judicial decisions, \*Drainage districts, Watersheds (Divides), Drainage effects, Sewers, Water management (Applied), \*Decision making, Project planning, Cost benefit theory, \*Construction costs, Drainage systems, Local governments, Cities, Cost allocation, Legal aspects.

The sewer district and other named parties submitted several questions relating to the construction of, and assessments to pay for, new drainage facilities. All the parties appealed from the decision of the Circuit Court, and the Court of Appeals held that, although the proposed addition was to be constructed wholly outside the Louisville City limits, the proposed plans must still be approved by the legislation body of the city. This was so because the word 'constructed,' as used in the statute, could not be said to refer only to the actual physical construction work. The court agreed with the determination that 'constructed' encompassed more than the situs of the physical construction, and, in this case, it included all areas which could reasonably be expected to be improved or affected as a result of the construction. Ordering the sewer district to secure the approval of the city alderman before proceeding

## Control of Water on the Surface—Group 4A

ing was not an unconstitutional subordination of the authority of the sewer district to that of the municipality. It could not be said that this ruling had the effect of permitting city and county officers to operate as officers of the sewer district in contravention of state constitutional prohibitions. In making assessment for the costs of the drainage improvements, it is not necessary to show a specific enhancement of value of each parcel of property affected to justify an assessment. (Blunt-Fla) W69-02887

**GRAVITY DRAINAGE DISTRICT NO 1 V KEY (CONDEMNATION PROCEEDING FOR DRAINAGE DITCH CONSTRUCTION).**

99 So 2d 82-88 (La 1958).

Descriptors: \*Louisiana, Judicial decisions, Drainage district, Condemnation, \*Drainage systems, \*Condemnation value, Damages, Severance, \*Culverts, Eminent domain.

Identifiers: \*Expropriation, Diminution in value.

Plaintiff sought to expropriate land for the construction of a drainage ditch. The basis of findings in an expropriation suit must be predicated on the physical value of realty taken at the time of taking and the diminution of value to realty after taking. The court found that the evidence supported the damages awarded. The award for one culvert adjoining each tract was held fair, although more than one culvert over the proposed ditch might be needed for industrial use of the remainder of the tracts. (Childs-Fla) W69-02888

**ALBURY V CENTRAL AND SOUTH FLORIDA FLOOD CONTROL DIST (NO COMPENSATION ALLOWED FOR CONSTRUCTION OF A DRAINAGE CANAL).**

99 So 2d 248-252 (3d DCA Fla 1957).

Descriptors: \*Florida, Judicial decisions, Local governments, Drainage, \*Reclamation, \*Drainage district, Canal construction, \*Compensation, Damages, Legal aspects, Eminent domain.

Identifiers: \*Swamp Land Act, Internal Improvement Fund.

Action was brought to enjoin defendants from the alleged unlawful invasion of plaintiffs' land for the purpose of building a drainage canal, and for compensation for property appropriated by defendants. The land in question was originally state land, granted under the Federal Swamp Land Act. The deed of these state lands reserved to the Trustees of the Internal Improvement Fund of the state and their successors the right to enter upon these lands to construct improvements necessary for their drainage or reclamation, absent a showing that the district's purpose was beyond the purpose of the reservation. The court held this to be sufficient authorization to construct a canal without compensation for damage to the plaintiff's land. (Childs-Fla) W69-02889

**WEIMER V CAUBLE (ACTION TO ENJOIN DIVERSION OF SURFACE WATERS ONTO PLAINTIFF'S LAND IN HARMFUL MANNER).**

214 Ga 634, 106 S E 2d 781-783 (1959).

Descriptors: \*Georgia, Judicial decisions, Damages, \*Natural flow doctrine, \*Alteration of flow, \*Surface waters, Surface runoff, Abatement, Legal aspects, Discharge (Water). Identifiers: Land descriptions, Injunction, Trespass, Demurrer.

Suit was brought to enjoin an alleged trespass and to recover damages caused by the discharge of water from defendant's land onto property belonging to the plaintiff on the ground that the natural flow of water had been changed. The trial court

overruled the general demurrer of defendant and granted relief to the plaintiff. The Supreme Court of Georgia reversed the trial court holding that the allegation of the petition that the plaintiff was the owner of valuable realty lying immediately southeasterly of, adjoining and adjacent to, the described realty of the defendant, was too vague and indefinite to be the basis of an action to enjoin the alleged trespass. The question of such a defective description could be raised by general demurrer. The court also stated that if the defendant had caused the natural flow of surface water to be concentrated and then discharged on the plaintiff's land causing damages, he would be liable. The court further stated that notice to the defendant that he would be held responsible for damages subsequently caused was tantamount to a request to abate the nuisance or trespass. (Watson-Fla) W69-02902

**CUGLAR V POWER AUTHORITY (EMINENT DOMAIN BY POWER AUTHORITY TO FORM POWER POOL).**

4 Misc 2d 879, 163 NYS 2d 902-931 (Sup Ct 1957).

Descriptors: \*New York, Administrative agencies, Administrative decisions, Judicial decisions, Legislation, \*Eminent domain, Condemnation, Islands, Dams, \*Reservoirs, \*Hydroelectric power, St Lawrence River, Rivers, Legal aspects.

Defendant Power Authority sought to appropriate plaintiffs' lands for a power pool in connection with the construction of dams on the St. Lawrence River. Such lands were not to be submerged, but were uplands which would be peninsular and islands when the land was flooded by the pool. Plaintiffs sought to enjoin the taking on the grounds that it was excessive and not for a public purpose. The Power Authority moved to dismiss for failure to state a cause of action. The Supreme Court, special term, granted the motion. The court was concerned mainly with the questions: (1) whether the taking in this case was authorized by statute; and (2) what degree of reliance was to be placed upon the administrative determination of the necessity of the taking. The court held that the taking was authorized, and that it was necessary for a public purpose. The land need not be 'intimately connected with' or 'absolutely necessary for' the public purpose, and the fact that the land will be leased does not necessarily make the taking for a private purpose. This decision was affirmed by the Supreme Court, Appellate Division. (Williams-Fla) W69-02993

**ADAMS V ADAMS (DAMAGE FROM OBSTRUCTING DRAINAGE DITCH).**

310 S W 2d 813-816 (Ark 1958).

Descriptors: \*Arkansas, Judicial decisions, Dams, Barriers, \*Flood damages, Overflow, Rent, Value, \*Obstruction to flow, Reasonable use, Storm runoff, Surface runoff, \*Damages.

Identifiers: \*Measure of damages.

Plaintiff landowner sued defendant for flood damage to his land allegedly resulting from an obstruction placed in drainage ditch along with torrential rains, which combined to cause an overflow onto the plaintiff's property, making cultivation impossible. The drainage ditch was part of a drainage district network and it was found that the defendants had not obtained the requisite permission of the drainage district before constructing the dam. The defendants claimed that the excessive rainfall, not their dam, was the cause of the plaintiff's damage. The Chancery Court ruled for the defendants, but this court reversed the decision. The evidence sustained the plaintiff's charge that the presence of the unauthorized dam, combined with the unusual rainfall, was a substantial factor in causing the overflow that damaged the plaintiff's lands. In situations like this the burden of establish-

ing damages is on the plaintiff. Since the plaintiff introduced no evidence that the crops destroyed had any market value, the rental or usable value of the land was the proper measure of damages. The plaintiff, by showing that the defendants were liable, but failing to fix his loss by the correct measure of damages, was entitled to nominal damages only. (Blunt-Fla) W69-02996

**BLYDENBURGH V AMELUNG (DAMAGES FOR ARTIFICIALLY IMPOUNDING AND DISCHARGING WATER ON NEIGHBOR'S LAND).**

309 S W 2d 150-154 (Ct App Mo 1958).

Descriptors: \*Missouri, Judicial decisions, Damages, \*Impounded waters, Water law, Surface waters, Repulsion (Legal aspects), \*Surface runoff, \*Riddance (Legal aspects).

The plaintiffs, landowners, brought this action to recover damages from defendants, adjoining landowners, which resulted when the defendants artificially impounded and discharged water on to the plaintiffs' property. The defendants had constructed a tile that ran from a small basin on their property to the property of the plaintiffs. The trial court awarded damages to the plaintiffs, and the Kansas City Court of Appeals affirmed. The court held that surface water is a common enemy and property owners may deflect it off their property. However, they may not collect such water and cast it on to adjoining property in increased and destructive quantities. The appellate court also held that although the instruction relating to damages was inaccurate because it permitted the jury to duplicate the amount of recovery, the verdict was not excessive, and therefore it did not constitute not reversible error. (Watson-Fla) W69-02997

**TRUSTEES OF INTERNAL IMPROVEMENT FUND V CLAUGHTON (THE RIGHT TO FILL SUBMERGED LANDS GRANTED BY THE TRUSTEES DOES NOT EXTEND BEYOND THE BOUNDARIES ACTUALLY CONVEYED).**

86 So 2d 775-792 (Fla 1956).

Descriptors: \*Florida, Judicial decisions, Islands, Beds, \*Riparian rights, \*Bulkheads, \*Land fills, Wetlands, Sand bars, Shallow water, Boundaries, Legislation, Tidal marshes, Legal aspects.

Identifiers: Internal Improvement fund, Swamplands Act, Riparian Rights Act.

Defendant was estopped to question the validity of plaintiff's title to submerged lands included in a grant by defendant out of tidal lands vested in the trustees by a 1913 statute. However, plaintiff was not authorized to fill beyond the boundaries conveyed. The right to fill under the 1856 Riparian Rights Act and the Butler Bill attaches only to uplands or lands other than sovereign lands. These acts are inapplicable to islands, sand bars, and shallow banks, title to which was vested by the legislature in defendant for purposes of sale. The provision in the act allowing sale by defendant and providing that grantees should have the right to 'bulkhead and fill in same' was only a grant of a special riparian right and did not bring such lands within the terms of the 1856 and 1921 Riparian Rights Acts. Thus, only the original lands conveyed could be filled. (Childs-Fla) W69-02999

**INJURIES TO DAMS AND WATER CHANNELS OF MILLS AND FACTORIES.**

NC Gen Stat sec 14-142 (1967).

Descriptors: \*North Carolina, \*Legislation, Mills, \*Dams, Channels, \*Industrial plants, Canals, Obstruction to flow, Industrial water.

## Field 04—WATER QUANTITY MANAGEMENT AND CONTROL

### Group 4A—Control of Water on the Surface

In North Carolina, by statute, if any person cuts away, destroys, or otherwise injures any dam, or obstructs or damages any race, canal, or other water channel erected, opened, used, or constructed for the purpose of furnishing water for the operation of any mill, factory, or machine works, or for the escape of water therefrom, he shall, upon conviction, be fined and/or imprisoned at the discretion of the court. (Watson-Fla)

W69-03001

#### HILTON V DUKE POWER CO (DAM ADDITIONS CAUSED FLOODING OF UPSTREAM LAND).

254 F 2d 118-126 (4th Cir 1958).

Descriptors: United States, \*South Carolina, Judicial decisions, \*Dams, \*Backwater, Dredging, Silt, Hydroelectric plants, \*Flooding, Water rights, Condemnation, Eminent domain, Impounded waters, Legal aspects, Water law.

Identifiers: Statute of limitations, Accrual of action.

Plaintiff brought this action for damage to his lands caused by the maintenance of a neighboring dam. Plaintiff's lands lie 12 miles upstream from the dam, and it is contended that the natural flow of the waters provided ample drainage before the erection of the dam. Still waters, in the lake formed behind the dam, caused silt to accumulate. The silting continued and gradually the creek banks on plaintiff's land, which had averaged six to eight feet, were diminished. The creek overflowed depositing water and silt on plaintiff's land. Under South Carolina law, there is liability if a dam is the proximate cause of injury to neighboring property, but the statute of limitations for damage to real estate affects the remedy. There is a 'taking' requiring just compensation and accrual of the right of action when neighboring real estate is actually invaded; but the statute of limitations does not begin to run until actual injury occurs. As long as the dam remained at the level established at the time of condemnation, the right acquired included damage that might accrue. The release signed by landowners extinguished every right existing at the time of release. However, a jury verdict awarding damages to the plaintiff was reinstated because a jury question was presented as to whether the damage was reasonably foreseeable within the meaning of the release. (Childs-Fla)

W69-03006

#### FRYE V PENNSYLVANIA RR (ACTION BY LANDOWNERS FOR DAMAGES FROM FLOODING CAUSED BY CLOGGED DRAINAGE PIPE UNDER DEFENDANTS RAILROAD).

187 Pa Super 367, 144 A 2d 475-477 (1958).

Descriptors: \*Pennsylvania, Judicial decisions, \*Railroads, Damages, \*Flooding, Drainage, Pipes, \*Culverts, Right-of-way, Rainfall, Legal aspects, Obstruction to flow, Streamflow, Streams.

Identifiers: Act of God, Debris.

This action was brought by landowners against a railroad for damages caused by flooding of certain of their lands due to clogging of a drainage pipe under defendant-railroad's right-of-way. The trial court entered judgment for the plaintiffs, but the Superior Court reversed, ordering a retrial. The Superior Court held that the measure of damages for restoration of the land to its former undamaged condition was the restoration cost at prices prevailing during the year of the damage. The admission of the testimony of a witness as to the restoration cost based on costs five years later was reversible error due to absence of evidence that there had been no change in prices between the year of the damage and 1956, the year when the witness inspected the property. The court also held that where flooding damage to the landowners' property did not result from rainfalls so extraordinary that their consequences could not have been foreseen,

but instead, was due to the clogging of a drain under the railroad's right-of-way, the damages could not be attributed to an act of God. (Watson-Fla)

W69-03014

#### CENTRAL MAINE POWER CO V PUBLIC UTIL COMM'N (RIPARIAN LAND PURCHASE TO AVOID LIABILITY FOR DAM OPERATION).

163 A 2d 762-789 (Me 1960).

Descriptors: \*Maine, \*Riparian rights, \*Dams, \*Reasonable use, Judicial decisions, Riparian land, Riparian waters, Electric power rates, Hydroelectric plants, Administrative decisions, Legislation, Water rights.

Identifiers: \*Mill Act.

Petitioner, Central Maine Power Company, sought review of an adverse determination by the Public Utilities Commission of an electricity rate claim. The Supreme Judicial Court held that the Commission erred in not admitting to the rate base of the electric company the value of the riparian lands and water easements purchased as property 'used or required to be used' in the public service. The court reasoned that it was necessary for the electric company to purchase this property in order to operate its plant without fear of violating the riparian rights of downstream proprietors through sudden, large releases of water necessary for the plant's operation. It was ruled that riparian ownership extends to the thread of the stream and includes a right to its natural flow and reasonable use, subject only to public rights of passage for fish, boats and logs. Water may not be diverted unlawfully or unreasonably. A riparian owner may use the stream for manufacturing or industrial purposes if the water is not unreasonably detained or essentially diminished. As to the relation of upper and lower riparian owners, if water is accumulated rightfully and lawfully in a reservoir above a dam, ordinary care must be exercised in releasing it. If accumulated wrongfully, the water is released at the peril of the upper owner. (Patterson-Fla)

W69-03017

#### FAIRCHILD V KRAMER (ACCESS TO ARTIFICIALLY CREATED BASIN).

11 App Div 2d 232, 204 NYS 2d 823-827 (1960).

Descriptors: \*Dredging, Channel improvement, \*Inlets, Marinas, \*Navigable rivers, Public rights, Judicial decisions, High water mark, Low water mark, Water law, Bulkhead line, Harbors.

Plaintiff, owner and lessee of a boat basin created through dredging some 67 years prior to the case, brought an action in trespass to restrain defendant from using the basin. Prior to the dredging, the area of the basin had been sand dunes through which a small creek passed and emptied into Long Island Sound. After the dredging, several creeks emptied into the basin which was connected to the sound. Defendant used the basin as an anchorage, claiming a right of use based on the theory that the dredging had enlarged the navigable area of the creek which it had supplanted. The lower court dismissed the complaint and the plaintiff appealed. It was held that evidence of the ebb and flow of the tide in the creek was insufficient to show its navigability, and a new trial was ordered. Under the modern and majority rule which prevails in the U.S. and N.Y., a waterway is navigable on fact only when it is used, or is susceptible of being used, in its natural, ordinary, and original condition, as a highway for commerce over which trade and travel are or may be conducted in the customary manner. If the stream was proved to be navigable, the basin would be accessible to the public.

W69-03018

#### BURKE V FREY (SURFACE WATER DRAINAGE).

358 Mich 606, 101 N.W. 2d 385-387 (1960).

Descriptors: \*Michigan, Judicial decisions, \*Surface runoff, \*Surface drainage, Drainage systems, Repulsion (Legal aspects), Lake Erie, Storm runoff, Flooding.

Property owners blamed surface flooding of their lots on the refusal of neighboring owners to reopen and maintain a drainage ditch. Plaintiffs alleged that defendants had lessened the efficiency of the method of drainage of their own property and that, in consequence, surface waters on occasion flowed onto plaintiffs' lots. The court stated that a landowner has a duty not to increase the natural flow of water upon a neighbor's land either by erecting barriers to natural drainage or by taking steps to facilitate drainage of his own property. It was held that defendants had not violated their duty to protect plaintiffs' property from surface water and that flooding had resulted from proximity to Lake Erie and the occurrence of unusually heavy storms. (MacMillan-Fla)

W69-03019

#### BECK V CITY OF NEW YORK (OVERFLOWING SEWERS).

199 NYS 2d 584-595 (N.Y. Sup Ct 1960).

Descriptors: \*New York, Judicial decisions, Damages, Cities, \*Sewers, Drainage systems, Storm drains, Storm runoff, \*Overflow, \*Flood damage, Land tenure.

Resident property owners sued New York City for flood damages resulting from overflowing storm sewers. The city was not required to install sewers at all. If a sewer system proves inadequate, a property owner is not entitled to compensation for this error in judgment in the absence of negligence. The court found that rainfall during the relevant specified period had been 'far greater than normal' and that plaintiffs failed to prove that negligence on the part of the city created the conditions and the resulting floods. (MacMillan-Fla)

W69-03020

#### BINO V CITY OF HURLEY (CONSTITUTIONALITY OF ORDINANCE DENYING RIPARIAN RIGHTS WITHOUT COMPENSATION).

273 Wisc 10, 76 N.W. 2d 571-581 (1956).

Descriptors: \*Wisconsin, Judicial decisions, Water law, Cities, \*Municipal water, Lakes, \*Riparian rights, Riparian land, \*Eminent domain, Easements, Legislation, Water pollution, Water supply, Legal aspects, Water sources, Swimming, Boating, Condemnation value, Compensation.

The plaintiffs owned all the land surrounding a non-meandered lake lying within the corporate limits of the City of Hurley. The plaintiffs granted the city an easement across their property to lay pipe and use the lake as a water supply. However, they specifically retained all riparian rights to the lake. The city later passed an ordinance prohibiting swimming, boating, and bathing in the lake. The plaintiffs brought this action for a declaratory judgment that the ordinance was unconstitutional. The trial court upheld the ordinance, but the Supreme Court of Wisconsin reversed, holding that riparian rights are property rights and it is a denial of due process to take them without just compensation. The Supreme Court also stated that the city could acquire the riparian rights by contract or the property could be acquired by eminent domain if necessary. (Watson-Fla)

W69-03021

#### GRASLEY V EPPLEY (SURFACE DRAINAGE).

134 NE 2d 742-746 (C.P. Ohio 1953).

Descriptors: \*Ohio, Judicial decisions, Legal aspects, \*Surface drainage, \*Repulsion (Legal aspects), Diversion structures, Barriers, \*Obstruction to flow, Surface runoff, Natural flow, Ditches.

## WATER SUPPLY AUGMENTATION AND CONSERVATION—Field 04

### Control of Water on the Surface—Group 4A

Plaintiffs sought an injunction to prevent defendant from interfering with the natural flow of drainage water passing between the adjoining plots of the parties. The court held that defendant could deepen and widen his portion of the ditch in order to prevent an overflow onto his land. He could not, however, erect artificial barriers or open passages between the adjoining lands in order to cause a flowage onto the lands of plaintiffs which would be disruptive of the natural topography of the land prior to his acts. (Molica-Fla)  
W69-03025

#### **SEC 452 WATER SUPPLY TO OTHER STATES.** N Y Conserv Law sec 452 (McKinney 1967).

Descriptors: \*New York, \*Legislation, Permits, Legal aspects, \*Fresh water, \*Transportation, Water resources, Administration, Administrative agencies, Interstate.

New York prohibits the transporting of waters by means of conduits, etc., from any fresh water body into another state unless, upon written petition, consent is obtained from the Water Resources Commission. The New York Supreme Court may enjoin any unauthorized transportation upon application by the Commission. (Molica-Fla)  
W69-03028

#### **NAVIGATION AND FLOOD CONTROL IMPROVEMENTS IN COOPERATION WITH THE FEDERAL GOVERNMENT.**

For primary bibliographic entry see Field 06E.  
For abstract, see .  
W69-03033

#### **STATE V CITY OF DEFIANCE (CONSTITUTIONALITY OF STATUTE REQUIRING CITIES TO FURNISH OUTSIDERS WITH WATER).** 167 Ohio St 313, 148 N E 2d 221-225 (1958).

Descriptors: \*Ohio, Judicial decisions, Legislation, \*Cities, Conduits, \*Pipelines, \*Water supply.  
Identifiers: Constitutional law.

McCann, the relator in this case, petitioned the Ohio Supreme Court to issue a writ of mandamus to compel the city to issue a permit allowing her to tap into the city's water line. McCann lived outside the city and relied upon Sec 743.13 of the Revised Code, which provided that if a city extended its water pipes beyond its limits at the expense of someone else, it must provide service to anyone along the extended line. The city alleged that this statute was unconstitutional because it purported to restrict the constitutionally granted power of a municipality to provide public utility services. The Ohio Supreme Court held the act unconstitutional and refused to issue the writ. (Williams-Fla)  
W69-03035

#### **BOARD OF SUPERVISORS OF LOUDOUN CITY V TOWN OF FAIRFAX (APPLICATION TO ERECT DAM FOR MUNICIPAL WATER SUPPLY).**

199 Va 612, 101 S E 2d 519-523 (Sup Ct App 1958).

Descriptors: \*Virginia, Judicial decisions, Water law, Legislation, \*Dams, \*Municipal water, Administrative agencies, \*Water supply, Water sources, Streams, Cities, Public Health, Administrative decisions.

The Town of Fairfax made application for permission to erect a dam for the purpose of establishing a water supply. The Board of Supervisors of Loudoun County and others were allowed to intervene as defendants. The trial court ruled in favor of the application, and the Supreme Court of Appeals of Virginia affirmed the decision. The court held that the evidence was sufficient to sustain the trial court's finding that a public necessity or an essen-

tial public necessity or an essential public convenience would be served by the erection of such a dam, and against the contention that the town could obtain water from other sources. The word 'necessity' within the statute, which authorizes erection of a dam where a public necessity or an essential public convenience will be served, does not denote an absolute, imperative, or indispensable necessity, but means reasonable necessity. (Watson-Fla)  
W69-03036

#### **SHEPHEARD V BOGGS (LAND EXTENSION BY RIPARIAN LANDOWNER BLOCKING STREAM).**

198 Va 299, 94 S E 2d 300-304 (Sup Ct App 1956).

Descriptors: \*Virginia, Judicial decisions, Water law, \*Riparian rights, Rivers, Streams, Dams, Piers, \*Boundaries (Property), \*Low water mark.

Plaintiffs brought this bill in equity to require a lot owner to remove an earthen dam and pier constructed across a small stream, flowing into a river. The Supreme Court of Appeals of Virginia held that the lot owner's property, which extended to the low water mark rather than a bluff line sloping from his lot down to the stream, ended at the stream in question. Therefore, the lot owner did have the riparian right to extend his property to the low water mark but he could not block the stream and deprive his neighbors of their riparian rights since they existed before the land was extended. (Watson-Fla)  
W69-03037

#### **CORDOVANA V VIPOND (INJUNCTION TO REMOVE FENCE WHICH DENIED RIPARIAN RIGHTS).**

198 Va 353, 94 SE 2d 295-299 (SC App 1956).

Descriptors: \*Virginia, Judicial decisions, Water law, Legislation, \*Riparian rights, \*Navigable waters, \*Boundary disputes, Streams, Shores, Low water mark, Riparian land, Ownership of beds, Streambeds.

The complainants sought a mandatory injunction in equity to require the adjoining property owners to remove a fence which denied the complainants their riparian rights. The trial court entered an order extending the property lines of the lots in question straight out into the stream without taking into account the irregular shore line. The Supreme Court of Appeals of Virginia reversed, holding that extending the property lines beyond the low water mark was a violation of statute and deprived the complainants of their riparian rights. The court also held that each riparian owner is entitled to a parcel of underwater land as wide at its outer end, upon the line of navigability, as the inner or shore end that the riparian owner possesses. (Watson-Fla)  
W69-03038

#### **CITY OF ASHLAND V KITTLE (LIABILITY OF A CITY FOR FLOODING CAUSED BY INADEQUATE CULVERT).**

305 SW 2d 768-769 (Ky Ct App 1957).

Descriptors: \*Kentucky, Judicial decisions, \*Flood damage, Overflow, Surface waters, \*Culverts, Rainfall, Cities, Surface runoff, Surface drainage, Legal aspects.

Plaintiff sued the city of Ashland, alleging injury to real estate caused by the overflow of surface water from a negligently constructed culvert. The Court found the culvert to be a temporary structure since it could be readily corrected or abated at a reasonable expense. Suits may be brought for each recurring injury resulting from a temporary structure. A municipal corporation is not liable for damages caused by extraordinary rainfall which could not have been anticipated by a person of ordinary experience. The evidence indicated that the extraor-

dinary rainfall experienced could have been anticipated and that the city failed to keep the culvert in condition to carry off water from an ordinary rainfall. The judgment awarding damages was affirmed. (Childs-Fla)  
W69-03040

#### **FLOOD PLAIN INFORMATION, HARPETH RIVER, FRANKLIN, TENNESSEE.**

Corps of Engineers, Nashville, Tenn.  
For primary bibliographic entry see Field 02E.

For abstract, see .  
W69-03041

#### **STEPS TOWARD A BETTER UNDERSTANDING OF URBAN RUNOFF PROGRESS,** Michigan Univ., Ann Arbor.

For primary bibliographic entry see Field 04C.  
For abstract, see .  
W69-03097

#### **ECONOMIC ANALYSIS OF ALTERNATIVE FLOOD CONTROL MEASURES,** Kentucky Univ., Lexington. Dept. of Civil Engineering.

James L. Douglas.  
Water Resources Res, Vol 3, No 2, pp 333-343, 1967. 11 p, 1 tab, 14 ref.

Descriptors: \*Flood control, \*Non-structural alternatives, \*Flood damage, \*Economic efficiency, \*Computer programs, Digital computers, Flood plains, Flood plain zoning, Floodproofing, Channel improvement, Flood plain insurance, Planning.  
Identifiers: Land use control.

A digital computer program was developed for determining the optimum combination of structural and nonstructural measures for flood control according to the criterion of economic efficiency. The program may be readily applied by any agency interested in analyzing the relative merits of structural and nonstructural measures or in more rapid economic analysis of alternative channel improvement designs. It selects the optimum combination of channel improvement, floodproofing, and land use control for each portion of the flood plain during planning stages of specified duration. The program was used to relate the optimum combination of the three measures to specific flood-plain properties. Finally, the sensitivity of the nature and the total cost of the optimum program was related for various flood-plain conditions to variation in cost of channel improvement, cost of land use control, cost of flood proofing, right-of-way value, value of the coefficient relating flood damage to flood severity, value of open space preserved in an urban area, extent of aversion to irregular timing of flood damage, discount rate, population projections, and the exclusion of alternative combinations.  
W69-03111

#### **RECREATIONAL USE OF MUNICIPAL RESERVOIRS,**

Cornell Univ., Ithaca, N. Y.; and Michigan State Univ., East Lansing.

For primary bibliographic entry see Field 06B.  
For abstract, see .  
W69-03136

#### **SIMULATION OF FLOOD FLOW DIVERSION FROM A LAKE SYSTEM,**

Southern Methodist Univ., Dallas, Tex.; and Northwestern Univ., Evanston, Ill.

Jerry R. Rogers, and Robert S. Gemmell.  
Proceedings of the Third Annual American Water Resources Conference (American Water Resources Assn; Urbana, Ill), c 1967, pp 285-293. 9 p, 1 map, 2 tab, 3 fig, 3 ref.

Descriptors: \*Model studies, Computer models, \*Flood control, Lakes, Lake Michigan, Illinois, River flow, Water level fluctuations.

Identifiers: \*Flood flow diversion, Lake system, Chain of Lakes.

## Field 04—WATER QUANTITY MANAGEMENT AND CONTROL

### Group 4A—Control of Water on the Surface

This study was directed at the evaluation of water export as a means for controlling floods on a small lake system. Stochastic flood simulations were based on the history of lake level fluctuations and an estimate of the stage-volume relationship for the lakes. The use of the General Systems Simulation language greatly facilitated construction of the computer model for simulation of lake flooding and diversion. The available economic data was inadequate to permit evaluation of diversion performance in economic terms, although such a procedure could have easily been incorporated in the simulation model. It is concluded that simulation technique has considerable merit, especially for the preliminary planning and evaluation of alternatives. (Winn-Rutgers)  
W69-03143

**DRAINAGE THEORY FOR REMOVAL OF EXCESS WATER FROM IRRIGATED LANDS,**  
Washington State Univ., Pullman. Dept. of Agricultural Engineering.  
Max C. Jensen.  
Washington Water Research Center, Completion Report, Dec 1968. 32 p, 4 tab, 11 fig, 9 ref, 1 append. OWRR Project A-006-Wash.

Descriptors: Drainage, \*Drainage theory, Drainage density, \*Drainage engineering, Drainage systems, Drainage water, Drainage wells, Drains, Pores, \*Porosity.

Gravel pack flow conductance envelopes around drain tile—previously wrongly called 'gravel envelope filters'—have important influences on drain performance. Boundary conditions created by conductance envelopes must be described in equations for mathematical solutions to be descriptive. Good conductance envelopes prevent solid particle movement. Outside surface of good conductance envelope can be used as minimum equipotential surface. Substantial amounts of water were found to move toward drain tile above water table. Hydraulic conductivity within capillary fringe zone was found to be nearly as high as saturated conductivity below water table. Above capillary fringe (zone of complete saturation) hydraulic conductivity rapidly decreased to near zero in two porous media investigated. Hence lateral water movement above capillary fringe was very small. By increasing definition of flow area in flow equations to include capillary fringe zone, a near accurate calculation of discharge was obtained.  
W69-03189

### 4B. Groundwater Management

**MENNE V CITY OF FOND DU LAC (RIGHT OF WATER REMOVAL TO NON-CONTIGUOUS LANDS),**  
77 N W 2d 703-707 (Wisc 1956).

Descriptors: \*Wisconsin, Judicial decisions, Water sources, \*Water wells, Relative rights, Water transfer, Water law, \*Competing uses, Water conservation, Reasonable use, \*Percolating water, Basins, Legal aspects, Water supply, Legislation.

The City of Fond du Lac planned to construct a well and remove water from other towns for the purpose of sale to non-contiguous property. Town residents brought action for an injunction against the construction and water removal. In the alternative, plaintiffs sought to restrain the city from removing water from the water basin under the towns to an extent constituting an unreasonable use by the city relative to the property rights of the plaintiffs. The Supreme Court affirmed the lower court's decision that the use of percolating water underneath an owner's land is a property right, and that water so obtained could be sold. The Court left the solution of the problem to the legislature, basing the opinion upon stare decisis. The dissenting opinion stressed that uses of one neighbor should not impair the substantially equal uses of another. (Wheeler-Fla)  
W69-02855

**RADIUS OF INFLUENCE OF A WELL,**  
For primary bibliographic entry see Field 02F.  
For abstract, see.  
W69-02946

**DUNCAN V GHEEN (ENFORCEMENT OF EASEMENT GRANTING RIGHT TO SPRING WATER),**  
185 Pa Super 328, 138 A 2d 168-170 (Super Ct Pa 1958).

Descriptors: \*Pennsylvania, Judicial decisions, \*Easements, Legal aspects, \*Spring waters, Springs, Water sources, Water users, Water contracts, \*Water rights, Water conveyance, Burrows, Domestic water, Rodents, Diversions, Conduits.

Plaintiff's predecessor in title acquired the right to the water of a certain spring on defendant's land. The easement was created by deed, with the spring serving as a source of water for domestic use. Due to burrowing marmots, the water was diverted underground from the original source of the spring. Plaintiffs, by the terms of the easement, had acquired the right to enter upon the defendant's land to keep in repair the conduit through which the water was conveyed via a catch basin to plaintiff's house. A subsequent grantee of the land containing the spring destroyed plaintiff's modifications to the conduit, alleging that such action became necessary due to the change in surface location of the spring. The lower court granted a permanent injunction restraining the defendants from interfering with the plaintiff's right to the water from the spring in accordance with the easement. The appellate court affirmed, ruling that it was immaterial that the location of the spring changed. (Wheeler-Fla)  
W69-03023

**OPTIMAL GROUNDWATER MINING,**  
Nevada Bureau of Mines, Reno. Desert Research Inst.  
P. A. Domenico, D. V. Anderson, and C. M. Case.

Water Resources Res, Vol 4, No 2, pp 247-255, April 1968. 9 p, 3 fig, 10 ref.

Descriptors: \*Water management (Applied), \*Groundwater mining, Water yield, Mathematical models, Economics, Withdrawal, Groundwater basins, Safe yield.

Identifiers: \*Optimal yield, Economics of water development.

Managerial concepts of yield from a groundwater basin, e.g. safe yield, encompass ambiguous considerations. A mathematical expression is presented that relates the economic worth of groundwater mining to the remaining worth of a basin after it has been partially depleted and permits establishment of an optimal, one-time storage reserve that may justifiably be exploited. With water-level position selected as the denominator common to both the ground-water basin and its economic worth, the extreme conditions of perennial use of natural replenishment and depletion of the entire reserve emerge as special cases of the general model. This is reflected through an expression for optimal mining yield, a one-time volume of nonrenewable water that may take on values ranging from zero to the maximum amount of usable water in storage. The maximizing conditions are expressed in terms of verbal decision rules and give new interpretation to the concept of overdevelopment generally associated with exceeding safe yield. A criterion is thus provided by which the economic state of development can be tested at any time. (Steinhilber-USGS)  
W69-03114

**SYSTEMS ANALYSIS FOR GROUND WATER BASIN MANAGEMENT,**  
California Univ., Berkeley. Dept. of Civil Engineering.  
David K. Todd.

California Water Resources Center, Technical Completion Report, Sept 1967. 9 p, 10 ref. OWRR Project A-003-Cal.

Descriptors: \*Systems analysis, Groundwater, Groundwater modeling, Optimization, \*Ground-water management, Groundwater quality.

The purpose of this project was to investigate fundamental problems of ground water dynamics and concepts for managing ground water basins. The research was conducted as a series of subprojects, the responsibility for each being assigned to a graduate student. The results have, or soon will be, reported in the form of 15 publications, including 22 articles in the technical journals, 7 research reports and 6 PhD dissertations. Following is a list of the subprojects completed: (1) Mechanics of Turbulent Flow; (2) Lateral Flow in the Unsaturated zone; (3) Optimization of a Ground Water Basin; (4) Theoretical Analysis of Groundwater Basin Operation Studies; (5) Scheduling of Water Resources Developments in Emerging Nations; (6) Techniques for determining Ground Water Flow Fields.  
W69-03200

### 4C. Effects on Water OF Man's Non-Water Activities

**BARTOW COUNTY V DARNELL (REQUIREMENTS FOR STATING A CAUSE OF ACTION FOR FLOOD DAMAGE),**  
97 S E 2d 610-612 (Ct App Ga 1957).

Descriptors: \*Georgia, Judicial decisions, Local governments, Damages, \*Highways, Land fills, \*Flood damages, \*Legal aspects, Surface runoff, Surface drainage.

Plaintiffs brought an action for damage to realty due to the construction of a highway by the county in such a manner that water along the highway flooded plaintiffs' property. A fill had been constructed, resulting in water being cast onto the property. It was held that these allegations stated a cause of action for damages under a statute, Ga Code Ann sec 95-1710, which does not require that the plaintiff prove negligence. The judgment upholding the plaintiffs' petition was affirmed. (Childs-Fla)  
W69-02880

**STATE V SIMS (ACTION TO COMPEL PAYMENT OUT OF ALLOCATED FUNDS FOR FLOOD DAMAGE CAUSED BY A STATE AGENCY),**  
97 S E 2d 295 - 299 (Sup Ct App W Va 1957).

Descriptors: \*West Virginia, Judicial decisions, State governments, Administrative agencies, Damages, \*Flooding, Highways, Bridges, Land fills, Rainfall, \*Compensation, \*Obstruction to flow, Dams, Legal aspects.  
Identifiers: State Road Commission (Florida).

An original mandamus proceeding was brought to compel the State Auditor to issue warrants for payment out of an appropriation made by the Legislature for damages caused by the negligence of the State Road Commission in construction and maintenance of a highway bridge. The court held that the State Road Commission was negligent in constructing a fill and bridge in such a manner that flooding was caused during heavy rainfall. Since such negligence would be actionable as between private persons, there existed a moral obligation upon the state to make compensation for damages caused by the flood. Where the state had made the appropriation for payment, it was the duty of the State Auditor to make the necessary disbursement. (Childs-Fla)  
W69-02881

## WATER SUPPLY AUGMENTATION AND CONSERVATION—Field 04

### Watershed Protection—Group 4D

#### **PREScott V HERRING (BOUNDARY DISPUTE).**

212 Ga 571, 94 S E 2d 417-422 (1956).

Descriptors: \*Georgia, Judicial decisions, Water law, Lumber, \*Boundary disputes, Mills, \*Ponds, Low water mark, Boundaries (Property), \*High water mark, Legal aspects.

Identifiers: Land descriptions.

Action was brought by decedent's heirs at law to enjoin defendants from cutting timber on decedent's land. The trial court ruled for the heirs and the Supreme Court affirmed, holding that, where the deed described the land conveyed as that covered by a certain mill pond to be maintained at no more than a certain maximum height and stated that the land was located in the northeast corner of a certain lot, the deed conveyed all the land covered by the pond, even though part of the land did not lie in the northeast corner of the lot. The Supreme Court also stated that, in construing the controlling rule is to ascertain the intentions of the parties. (Watson-Fla)

W69-02882

#### **ROSKIN BROS, INC V STATE (LIABILITY OF STATE FOR NEGLIGENCE MAINTENANCE OF CULVERT).**

160 NYS 2d 32-35 (Ct Cl 1957).

Descriptors: \*New York, Judicial decision, \*Water injury, State government, Roads, Surface drainage, Surface runoff, \*Culverts, Roads, Floods, Percolating water, Seepage, \*Excessive precipitation, Legal aspects.

Identifiers: Negligence, Evidence, Proximate cause.

Claimant sought to recover from the State for water damage to his property and building following the alleged negligence of the State in allowing a culvert under a state highway to become clogged during a three-day rain, causing water to back up. Claimant alleged that, due to the blockage of the culvert, overflow-water percolated and flowed over the land to a point where it seeped into his basement. The court held that the State had been negligent in removing a screen from the culvert and not replacing it for a period of six months before damage. However, Claimant had not demonstrated that the State's negligence was the proximate cause of the injury suffered. Claimant introduced expert testimony to the effect that the waters which entered his basement were those from the overflow of the culvert, but the court stated that this testimony was not based on proven facts and therefore lacked probative force. (Williams-Fla)

W69-02992

#### **RINALDI V STATE (DAMAGE FROM STANDING WATERS).**

4 Misc 178, 158 NYS 2d 271-273 (1956).

Descriptors: \*New York, \*Standing waters, Muck soils, Floods, Judicial decisions, Legal aspects, Highways, Crops, \*Damages, Surface waters, \*Road construction, Ponding.

Plaintiffs, owners of a muck farm, had their onion crop destroyed by water accumulating on their lands. They sued the state, alleging that negligence in the construction of a highway caused the harmful accumulation. The court found that this allegation was not sustained by the proofs and dismissed the cause. (Scott-Fla)

W69-02994

#### **CITY OF MADISON V STATE (PUBLIC BUILDINGS ON FILLED LAKE LAND).**

1 Wisc 2d 252, 83 NW 2d 674-679 (1957).

Descriptors: \*Wisconsin, \*Cities, \*Landfills, Legal aspects, Judicial decisions, Public benefits, Construction, Navigable lakes, Public rights, Riparian rights, Public lands, Reclamation, Boating, Fishing. Identifiers: Dockline, Lake Monona.

Action by city seeking declaration of its right to erect an auditorium and civic center on a filled area of Lake Monona. City filled a portion of lake and made it into parks, etc. It then proposed to build a civic center and auditorium on the filled property. The proposed construction would not interfere with the navigable character of the lake. A statute passed in 1927 established a dock line in the lake and authorized the city to construct in or on the lake out to this line. The court held that a building of the type described was not so unrelated to the use and enjoyment of the lake as to be outside the scope of the term 'public buildings.' Enjoyment of scenic beauty has been recognized as one of the public rights in navigable waters. Disappointment to those who would desire to boat, fish or swim in the area to be filled is negligible when compared with the greater convenience to be afforded those members of the public who will use the building. The city is authorized to expand tax money for this project. (Shevin-Fla)

W69-03022

#### **STEPS TOWARD A BETTER UNDERSTANDING OF URBAN RUNOFF PROGRESS,** Michigan Univ., Ann Arbor.

E. F. Brater.

Water Resources Res, Vol 4, No 2, pp 335-347, April 1968. 13 p, 9 fig, 20 ref.

Descriptors: \*Infiltration, \*Rainfall-runoff relationships, \*Urbanization, Runoff, Hydrographs, Analysis, Retention, Rainfall, Michigan, Watersheds (Basins).

Identifiers: Detroit metropolitan area, Hydrologically impermeable area.

Rainfall and runoff from drainage basins in various stages of urbanization were analyzed to determine the initial retention, the hydrologically significant impermeable area, and the infiltration capacities of the permeable portions of the basins. The drainage basins, varying in size from 9.5 to 185 sq mi, are located in the Detroit metropolitan area. Techniques were developed that largely eliminated personal judgment in separating surface runoff from groundwater discharge. Infiltration capacities in this region are from 3 to 5 times higher in late summer than in early spring. The average initial retention for the basins studied is approximately 0.2 in. The hydrologically significant impermeable area appears to be closely related to the population density, but the effect of other factors is being studied. An investigation of the cause of seasonal and short period variations of infiltration capacity may provide a better understanding of the infiltration process.

W69-03097

#### **CONSERVATION DECISION-MAKING: A RATIONALIZATION,** Southern Illinois Univ., Carbondale.

Ronald Beazley.

Natural Resources Journal, Vol 7, No 3, pp 345-360, July 1967. 16 p.

Descriptors: Natural resources, \*Decision making, \*Conservation, Environmental effects, \*Land management, Multiple purpose, Institutions, \*Social values.

Identifiers: Uncertainty, Pressure groups, Feed-back.

Conservation is the establishment and observation of economically, socially, and politically acceptable norms, standards, patterns or models of behaviour in the use of natural resources by a given society. The magnitude and implications of conservation should not be underestimated. In the aggregate the effects of these requirements are great, representing millions and perhaps billions of dollars

annually in the way we use natural resources. These effects have further multiple reactions throughout the whole economy and society, quite outside of what we generally think of literally as conservation. In this sense conservation decision-making deserves a great deal more effort and care than we have given it. Ultimately, the obligation of conservation is to pass along resource potential to those in the future, while trying to raise that potential through research in conservation values, technology, organization, and decision-making. (Sokoloff-Rutgers)

W69-03127

#### **4D. Watershed Protection**

##### **DETACHMENT OF SOIL PARTICLES IN SIMULATED RAINFALL,** Nebraska Univ., Lincoln. Dept. of Agronomy.

Andrew P. Muzurak, and Peter N. Mosher.  
Soil Sci Soc of Amer Proc, Vol 32, No 5, pp 716-719, Sept-Oct, 1968. 4 p, 3 fig, 1 tab, 8 ref.

Descriptors: \*Soil erosion, \*Impact (Rainfall), Sediments, Erosion, Particle size, Water management (Applied), Soil conservation, Soil water movement.

Identifiers: Particle detachment, Splash erosion.

Discussed is the relation between falling raindrops and detachment of soil particles from a soil mass, which is the first stage of erosion. Information is presented that relates particle diameter to rainfall intensity when soil particles are exposed to simulated rainfall. Experimental procedure involved subjecting separates of soil materials of various particle sizes to variable simulated rainfall intensities. The amount of detached soil particles was linearly related to simulated rainfall intensity. Detachment of soil particles exposed to simulated rainfall increased from 2.2 mg per cubic centimeter of water for separates 4,760 to 3,360 microns in diameter to a maximum amount of 288 mg per cubic centimeter of water for separates 210 to 149 microns and 149 to 105 microns in diameter. Then the amount of detached particles decreased with decreasing diameter of particles. Detachment for less than 2 micron diameter particles was 11 mg per cubic centimeter of water. (Steinilber-USGS)

W69-02832

##### **APPLICATION OF THE GRAVITY SURVEY METHOD TO WATERSHED HYDROLOGY,** Agricultural Research Service, Tucson, Arizona. Southwest Watershed Research Center.

Daniel P. Spangler, and Fred J. Libby.  
Groundwater, Vol 6, No 6, pp 21-26, November-December 1968. 6 p, 4 fig, 1 tab.

Descriptors: \*Watersheds (Basins), \*Gravity studies, Arizona, Groundwater, Alluvium, \*Surveys, \*Hydrogeology, \*Hydrology, Density, Semiarid climates, Geophysics, On-site investigations, Mapping, Data collections, Variability.

Identifiers: Walnut Gulch Experimental Watershed (Tombstone—Arizona).

A gravity survey was conducted which covered 250 square miles and included the Walnut Gulch watershed at Tombstone, Arizona. This survey method detects and measures variations in the earth's gravitational force which are associated with changes in rock and alluvium density near the surface. Before making extensive surveys by the seismic refraction method, the gravity survey method was chosen as the geophysical method that would give a regional picture of the subsurface geology. The area was found to be typical of Basin and Range physiography, with isolated mountain blocks separated by broad alluvium-filled basins. The principals of the gravity survey method, the field procedures, and the data reduction technique used were described in the report. It was shown that the gravity survey method can be applied to watershed ground-water hydrology. (Affleck-Arizona)

W69-02982

## Field 05—WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5A—Identification of Pollutants

#### 05. WATER QUALITY MANAGEMENT AND PROTECTION

##### 5A. Identification OF Pollutants

###### THE TEMPORAL AND SPATIAL DISTRIBUTION OF DISSOLVED OXYGEN IN STREAMS, Manhattan Coll., Bronx, N. Y.

Donald J. O'Connor.

Water Resources Res, Vol 3, No 1, pp 65-79, 1967. 15 p, 5 fig, 1 tab, 17 ref.

Descriptors: \*Dissolved oxygen, \*Surface waters, \*Water pollution, \*Mathematical studies, Continuity equation, Spatial distribution, Temporal distribution, Aeration, Biochemical oxygen demand, Chemical oxygen demand, Temperature, Streamflow, Channel morphology.

Identifiers: Stream ecosystem.

The geophysical characteristics of drainage basins and the biochemical and physical environment of rivers affect the concentration of dissolved oxygen. These factors are embodied in a fundamental equation of continuity that describes the oxygen balance. Variations of the fresh-water flow and cross-sectional area are included, as well as sources and sinks of oxygen, including natural and artificial aeration, the photosynthetic contribution, bacterial and algae respiration, carbonaceous and nitrogenous oxidation, and benthal deposits. Application of the basic equation is summarized by two general cases, the first in which bacterial respiration and spatial profiles are significant and the second in which the algae activity and the temporal changes are predominant. The equations provide functions to assess water quality and pollution and to determine the effect of many natural or artificial changes in the stream environment.

W69-02809

###### URBANIZATION AND ITS EFFECT ON THE TEMPERATURE OF LONG ISLAND STREAMS, Geological Survey, Washington, D. C.

Edward J. Pluhowski.

U.S. Geol Surv open-file rep, 277 p, 1968. 56 fig, 13 tab, 38 ref, 3 append.

Descriptors: \*Urbanization, \*Temperature, \*Streamflow, \*Thermal pollution, Storm runoff, Vegetation effects, Solar radiation, Reservoirs, Heat budget, New York.

Identifiers: Long Island (New York).

To isolate and evaluate the effect of man-made changes of stream temperature, the thermal patterns of 5 streams on Long Island, New York, were defined and analyzed. The Connetquot River is included as a control stream because its upper part is in essentially its natural state. Urban development on the other 4 basins ranges from slight to nearly complete; otherwise the 5 streams are similar. Urban development has increased stream temperatures in summer by 10-15 deg F by the construction of ponds and lakes, clearcutting of vegetation from streambanks, increasing storm runoff, and reducing groundwater inflow. Winter stream temperature average 3-5 deg F lower than normal. Stormwater runoff raised stream temperatures 10-15 deg F on August 25-20, 1967. Shading on the Connetquot River reduces incoming solar radiation as much as 70%. Solar radiation and groundwater seepage are the most important controls on stream thermal patterns on Long Island and are the most easily influenced by human activity. Energy budget methods were developed to assess modifications in natural stream environments. (Knapp-USGS)

W69-02830

###### FIELD AND LABORATORY EVALUATIONS OF BIOASSAYS FOR NITROGEN AND

###### PHOSPHORUS WITH ALGAE AND AQUATIC WEEDS, Wisconsin Univ., Madison. Engineering Experimental Station.

George P. Fitzgerald.

In: Detection of limiting or surplus nutrients in algae, 9 December 1968. 12 p. WP-297.

Descriptors: \*Chlorophyta, \*Cycling nutrients, \*Enzymes, \*Essential nutrients, \*Nitrogen cycle, \*Nutrient requirements, Algae, Analytical techniques, Aquatic algae, Aquatic microbiology, Aquatic productivity, Aquatic weeds, Bioassay, Cyanophyta, Environmental effects, Eutrophication, Limnology, Nitrogen compounds, Nitrogen-fixation, Phosphorus compounds, Physiological ecology, Phytoplankton, Pollutant identification, Rain, Rainfall-runoff relationships, Rain water, Rooted aquatic plants, Water pollution, Water pollution control, Water pollution effects, Water pollution sources, Sewers.

The rate of ammonia absorption in the dark and the amount of orthophosphate extracted by boiling water treatments have been used to follow the transient nature of the nitrogen and phosphorus nutrition of algae and aquatic weeds. The measurement of the enzymatic activity of algal alkaline phosphatase also used to follow phosphorus nutrition has been shown to be inhibited by the presence of 5 mg/L or more of phosphate-phosphorus, but the actual enzymatic activity of the algae is not inhibited by phosphate-phosphorus and is reduced only by growth (or dilution) under conditions of surplus available phosphorus. It is suggested that only terminal portions of aquatic weeds be used for nutritional bioassays because of nutritional differences between young and old portions of the same plant. Available nitrogen compounds related to rainfall have been shown to influence the nitrogen nutritional status of Spirogyra and Cladophora. In applications of bioassays the importance of testing each species of plants separately is shown by contrasting results obtained with nitrogen-fixing (phosphorus-limited) and non-fixing (nitrogen-limited) blue-green algae from the same environment.

W69-03186

###### TRACE AND TRACER ELEMENTS IN GROUND WATER, Arizona Univ., Tucson. Dept. of Hydrology.

For primary bibliographic entry see Field 02F.

For abstract, see .  
W69-03197

#### 5B. Sources of Pollution

###### AQUEOUS TRANSPORT OF DIELDRIN RESIDUES IN SOILS, Cincinnati Univ., Ohio., Environmental Health Engineering.

J. David Eye.

J. Water Pollut Contr Federation, Vol 40, No 8, Part 2, pp R316-332, Aug 1968. 17 p, 4 fig, 7 tab, 44 ref.

Descriptors: \*Soil water movement, \*Dieldrin, \*Organic soils, \*Adsorption, Ion exchange, Solubility, Anion adsorption, Cation adsorption.

The apparent solubility of dieldrin in water ranges from 100 ppb at about 10 deg C at 300 ppb at 40 deg C. Its adsorption at equilibrium follows the Langmuir isotherm. In both equilibrium and column percolation experiments, the cation- and base-exchange capacities, specific surface areas, and clay contents of the various soils tested did not appear to affect adsorption capacity strongly, but higher organic contents appeared to be related to high adsorption capacity. At 20 deg C about 3 acre-ft of soil can be saturated by 1 lb of dieldrin. When dieldrin is applied at 1 lb/acre, only 0.06 ft of soil depth could be saturated with dieldrin if the soil density were 90 lb/cu ft and adsorptive capacity 5,000 mg/g. At the latter capacity and 25 deg C, and infiltration of 12 in./yr, 48 yr would be

required to saturate the soil to 1 ft depth. Since 5,000 mg/g is far less than the adsorptive capacities of most natural soils and clays, danger to groundwater supply appears remote. (Knapp-USGS)  
W69-02801

###### COMPOSITION OF WATER DISCHARGED FROM BITUMINOUS COAL MINES IN NORTHERN WEST VIRGINIA, West Virginia Univ., Morgantown.

Robert G. Corbett, and Douglas J. Growitz. Econ Geol, Vol 62, No 6, pp 848-851, Sept-Oct 1967. 4 p, 1 tab, 10 ref.

Descriptors: \*Acid mine water, \*Water analysis, Chemical analysis, Data collections, Trace elements, Water chemistry, West Virginia.

Chemical analyses were made of 5 samples of bituminous coal mine water to determine ferrous iron, total iron, aluminum, manganese, sodium, potassium, calcium, magnesium, chloride, sulfate, silica, and pH. Selected trace elements were sought in 2 of the 5 samples chosen because of their extreme values in pH (3.2 and 7.4). Four of the samples may be considered 'acid mine drainage' so characterized by pH of from 3.2 to 5.5, total iron in excess of 500 ppm, and aluminum greater than 100 ppm in the more acid samples. The fifth sample resembles uncontaminated ground water from the Monongahela Group and has a pH of 7.4, total iron less than 4 ppm, and aluminum less than 20 ppm. Similar distinctions in composition are reflected in trace elements of the 2 extreme samples. Marked differences in the neutral sample and the acid samples indicate the efficacy of minimizing contact of water with the underground workings. Water of good quality is discharged from a mine designed to minimize residence time of water in the workings, whereas the acid samples come from mines with more extensive drainage systems. (Knapp-USGS)  
W69-02804

###### MATHEMATICAL MODEL FOR UNDERGROUND DISCHARGE OF RADIOACTIVE GASES,

Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.

L. G. King.

Battelle-Pacific Northwest Lab Rep, 21 p, Mar 1967.

Descriptors: \*Mathematical model, \*Radioactive waste disposal, \*Gases, Underground storage, Methodology, Steady flow, Homogeneity, Injection wells, Darcys law, Soil moisture.

Identifiers: \*Radioactive gases, Isothermal flow, Symmetric system.

Injection of radioactive gas into the partially saturated section above the water table was investigated with mathematical models. One model was used during injection and another after cessation of injection. Assumptions made were: the gas obeys the Darcy equation, soil moisture is immobile, flow is isothermal and steady, soil is homogeneous and isotropic, soil moisture content is uniform, equation of state for dry air is sufficient to describe the gas, the gas is compressible, and the system is symmetric about the axis of the injection well. Calculated and measured values were found to be in satisfactory agreement. (Lang-USGS)  
W69-02813

###### VIRUS MOVEMENT IN GROUNDWATER, Arkansas Univ., Fayetteville; and Stanford Univ., Calif.

William A. Drewry, and Rolf Eliassen.

J. Water Pollut Contr Federation, Vol 40, No 8, Part 2, pp R257-R271, Aug 1968. 15 p, 7 fig, 4 tab, 27 ref.

Descriptors: \*Viruses, \*Groundwater movement, \*Adsorption, \*Soils, Soil chemical properties, Soil physical properties, Soil texture, Fissures (Geology).

# WATER QUALITY MANAGEMENT AND PROTECTION—Field 05

## Sources of Pollution—Group 5B

Identifiers: Virus adsorption on soils, Viral ground-water contamination.

Experiments in which water containing radioisotope-tagged viruses was passed through columns of various soils showed that virus retention by soils is an adsorption process characterized by linear adsorption isotherms. The adsorption is greatly affected by pH of the soil-water system, being greatest at pH of 7.0-7.5 and decreasing at higher pH. Increasing the cation concentration in the liquid enhances virus adsorption by some soils. The ability of a soil to adsorb viruses cannot be judged by the normally measured soil characteristics. Virus movement through saturated soils should present little hazard to underground water supplies provided that soil strata are continuous and the usual public health practices of separation of wells and disposal systems are followed.  
W69-02824

### A MODEL OF MIXING AND DISPERSION IN SAN FRANCISCO BAY,

California Univ., Berkeley.

Robert E. Selleck.

J Water Pollut Contr Federation, Vol 40, No 11, Part 1, pp 1873-1886, Nov 1968. 14 p, 9 fig, 5 ref.

Descriptors: \*Mixing, \*Dispersion, - \*Bays, Biochemical oxygen demand, Chlorides, Dissolved oxygen, Waste water (Pollution), Diffusion, California.

Identifiers: \*San Francisco Bay.

A method of predicting solute distributions in a system with various hydrologic and waste discharge conditions was developed as part of an investigation of water and sediment quality of San Francisco Bay. The model was developed using a one-dimensional diffusion analogy. The coefficient of dispersion was determined from chloride and dissolved silica concentration distributions. Examples of steady- and unsteady-state conservative and non-conservative systems are given. Observed and predicted results are comparable. The dispersion coefficient is proportional to the 0.75 power of net advective velocity. Chlorosity at Chipps Island ranged from 2.0 to 5.0 g/l with a decay rate in South Bay of 0.20 per day. (Knapp-USGS)  
W69-02831

### SOME HYDROLOGICAL OBSERVATIONS IN AUCKLAND AND OTAGO HARBOURS,

Auckland Univ. (New Zealand); and Marine Biological Station, Port Erin, Isle of Man (England).

For primary bibliographic entry see Field 02L.

For abstract, see .

W69-02835

### CITY OF MURPHYSBORO V SANITARY WATER BOARD OF ILLINOIS (POLLUTION ABATEMENT).

134 NE 2d 522-525 (4th DCA Ill 1956).

Descriptors: \*Illinois, Judicial decisions, Legal aspects, \*Water pollution, \*Public health, Sewage disposal, Sewage treatment, \*Cities, Fouling, Domestic water, Rivers, Fish.

Identifiers: Nuisance.

Defendant city discharged its untreated sewage into a river downstream from a point at which it obtained their water supply for domestic use. Under certain conditions the river would reverse itself, so that waters from below the outlets would get into the intake system. (However, the waters was still fit for drinking purposes). The court held that the order by the sanitary Water Board directing the city to cease discharging the sewage into the river was proper because such discharge created a nuisance and was detrimental to fish. The Sanitary Water Board Act prohibits disposal of matter into state waters which causes pollution. Pollution encompasses such acts as tend to create a nuisance.  
(Watson-Fla)

W69-02898

### RESERVOIRS.

N Y Village Law sec 231 (McKinney 1966).

Descriptors: \*New York, \*Legislation, Water law, \*Reservoirs, Water storage, Public health, Water pollution, Water supply, Water sources, Water works, Vegetation, Degradation (Decomposition), Decomposing organic matter, \*Banks, Gravels.

In the construction of a storage reservoir connected with a system of water works in the State of New York, all vegetable or other matter subject to decay must be removed from the banks of the reservoir site between its highest and lowest possible flow line, or such space must be covered by gravel or stone to prevent such decay. (Watson-Fla)  
W69-02874

### POLLUTION OF WATER ON LANDS USED FOR DAIRY PURPOSES.

N C Gen Stat sec 14-382 (1967).

Descriptors: \*North Carolina, \*Legislation, Cities, \*Water pollution, \*Dairy industry, Farms, Milk, Pasture management, Grazing, Grasslands, Wastes, Sewage, Animal wastes (Wildlife), Mine wastes, Chemical wastes, Sewage disposal.

It is unlawful for any person, firm, or corporation owning lands adjoining lands which are, or may be, used for dairy purposes or for grazing milk cows to dispose of, or permit the disposal of, any animal, mineral, chemical, or vegetable refuse, sewage, or other deleterious matter in such a way as to pollute the waters on the lands so used, or which may be used, for dairy purposes or for grazing milk cows, or to render unfit or unsafe for use, the milk produced from cows feeding upon the grasses and herbage growing on such lands. This statute does not apply to incorporated towns maintaining a sewer system. Anyone who violates this statute is guilty of a misdemeanor punishable by a maximum fine of \$50 and/or 30 days imprisonment. Each day that the pollution is committed or exists constitutes a separate offense. (Watson-Fla)  
W69-02893

### HILLHOUSE V CITY OF AURORA (ACTION FOR DAMAGES BROUGHT BY FARM OWNER FOR POLLUTION OF CREEK BY CITY SEWER SYSTEM).

E-3146 S 2d 883-890 (Mo Ct App 1958).

Descriptors: \*Missouri, Judicial decisions, Damages, \*Cities, Water pollution, Sewage, Legislation, Farms, \*Sewage disposal, Invasion, Abatement, Feasibility, \*Streams, Legal aspects.

The owners of a farm brought this action against the city for damages sustained during 1955-56 because of the pollution of a creek running through the farm by wastes from the sewage system constructed by the city in 1923. The city claimed that the action was barred by a five year limitation statute since the nuisance was permanent and was created in 1923. The trial court entered a judgment in favor of the landowners, but the Court of Appeals set the judgment aside and remanded the case for further proceedings. The appellate court held that the instruction of the trial judge was reversible error. The instruction, in effect, directed a verdict for the landowner because it did not require the jury to find when the permanent nuisance resulted. This was prejudicial in that the five year statute of limitations would have begun to run only at the time when the course of action occurred. A permanent nuisance occurred when the operation of the sewage system resulted in substantial invasion or intrusion of the use or enjoyment of the farm.  
(Watson-Fla)  
W69-02898

SPAUGH V CITY OF WINSTON-SALEM (DAMAGES FOR POLLUTION).  
249 N C 194, 105 SE 2d 610-614 (1958).

Descriptors: \*North Carolina, \*Water pollution, \*Damages, Judicial decisions, Local governments, Sewage districts, Sewage, Odor, Disposal, Reasonable use, Easements, Water pollution effects, Legal aspects, Water rights.

Plaintiff alleged that defendant, city of Winston-Salem, emptied sewage into a creek, thereby causing their nearby residence to become unfit for use and habitation, and causing the sand in the stream bed of a separate tract to be unusable and unmarketable for use in their business of pumping out sand for use in construction work. Plaintiff was awarded permanent damages for the partial taking of his land. The court held that this award vested a permanent easement in the defendant. The court also held that the fact that the jury sought to award temporary damages without a request for same by plaintiff was not reversible error, as long as the verdict was, as in this case, founded upon the same cause of action. (Scott-Fla)  
W69-03011

### BOARD OF HEALTH V CREW (STATE'S RIGHT TO ORDER WELL CLOSING).

For primary bibliographic entry see Field 05G.

For abstract, see .

W69-03024

### DISCHARGE OF SEWAGE INTO WATERS (PERMITS REQUIRED).

For primary bibliographic entry see Field 06E.

For abstract, see .

W69-03029

### ACTIONS BY MUNICIPALITIES TO PREVENT DISCHARGE OF SEWAGE INTO WATERS.

N Y Pub Health Law sec 1157 (McKinney 1954).

Descriptors: \*New York, \*Pollution abatement, \*Potable water, \*Water quality control, Legislation, Legal aspects, Administrative agencies, Sewage, Water pollution sources, Public health, Domestic water, Water quality, Water pollution control, Impaired water quality, Pipes, Cities, Local governments, Inspection, Water analysis.

Any municipality which provides for the disposal of sewage may maintain an action in the Supreme Court to prevent the discharge of sewage into any body of water located in the same county as the city and from which the city takes its water supply when such discharge injures the potable quality of the water. Before such action may be brought, the Department of Public Health must determine, by examination at the city's expense, whether the sewage does pollute the water. When it is so determined, the Supreme Court shall issue a mandatory injunction, including as a part of that injunction plans for the discontinuance of such discharge of sewage. Those plans must be submitted to the Department for its approval. Section 1168, N Y Pub Health Laws (McKinney Supp 1968) states that Sec 1157 shall be in force only until April 1, 1969. (Sisser-son-Fla)  
W69-03031

### ORDER TO DISCONTINUE POLLUTION OF WATERS.

For primary bibliographic entry see Field 06E.

For abstract, see .

W69-03032

### CITY OF GALLIPOLIS V STATE EX REL WATER POLLUTION CONTROL BD (DENIAL OF PERMIT TO DISCHARGE SEWAGE INTO RIVER).

145 NE 2d 237-240 (Ct App Ohio 1957).

Descriptors: \*Ohio, Water pollution, Legislation, Administrative agencies, \*Administrative deci-

## Field 05—WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5B—Sources of Pollution

sions, \*Permits, Cities, \*Sewage, Rivers, Ohio River, Water law, Legal aspects.

The city appealed from a final order of the Water Pollution Control Board of Ohio which denied the renewal of a permit previously granted to the city. The permit allowed the city to discharge untreated sewage into the Ohio River for a limited period of time, and its renewal was to be conditioned upon the city's taking the initial steps toward the establishment of a sewage treatment plant. The city failed to meet the condition and consequently the renewal of its permit was denied. The Common Pleas Court reversed the Board's order, but on appeal to the Ohio Court of Appeals, that decision was reversed and the Board's order reinstated. The Court of Appeals held that the denial of the permit under these circumstances was within the discretion granted to the Board by statute, and that there was sufficient evidence to deny renewal of the permit. (Williams-Fla)

W69-03034

#### NEWMAN V CITY OF EL DORADO SPRINGS (ACTION FOR POLLUTION CAUSED BY CITY'S SEWAGE SYSTEM).

292 SW 2d 314-321 (Ct App Mo 1956).

Descriptors: \*Missouri, Judicial decisions, Cities, \*Damages, Riparian land, \*Water pollution, Outlets, Sewage system, Drainage, Condemnation, Eminent domain, Watercourses (Legal), Legal aspects, \*Riparian rights.

Identifiers: \*Measure of damages.

Plaintiffs, as lower riparian landowners, sued a municipality for damages sustained because of the pollution of a watercourse from the outfall in the drainage of the municipality's sewer system. The municipality had appropriated the right to dump sewage in the watercourse about the year 1903, but there was never any temporary or permanent nuisance that affected plaintiffs' land prior to the year 1952. The court, in affirming a verdict for the plaintiff, stated that if the nuisance created by the municipality necessarily follows the right to dump sewage as an inherent, permanent result, then it is merged with and becomes part of the appropriation of the right, and the measure of damages is the diminution of value of the land affected. But, if the nuisance created is reasonably remediable, and, therefore a right of action in the riparian owner arises each time the nuisance is imposed, the measure of damages is the extent of damage resulting from that particular occasion. The nuisance was held to be a temporary nuisance. The right acquired to dump sewage was held not to include the right to create a nuisance. (Childs-Fla)

W69-03039

#### SIGNIFICANCE OF NITRIFICATION IN STREAM ANALYSIS-EFFECTS ON THE OXYGEN BALANCE,

Michigan Water Resources Commission, Lansing. Robert J. Courchaine.

J Water Pollut Contr Federation, Vol 40, No 5, Part 1, pp 835-847, May 1968. 13 p, 12 fig, 11 ref.

Descriptors: \*Biochemical oxygen demand, \*Nitrification, \*Dissolved oxygen, \*Streams, Municipal wastes, Nitrogen fixing bacteria, Nitrates, Water Pollution sources, Michigan.

Identifiers: Lansing (Michigan), Grand River (Michigan).

A study of biological oxygen demand of the Grand River below Lansing, Michigan, determined that oxidation of nitrogenous material was the single most important source of oxygen demand. About 2/3 of the effluent nitrate load was oxidized in a 17.5 hr period. The high rate of nitrification and the high proportion of nitrogenous to carbonaceous BOD are associated with optimum nitrification water temperatures of about 30 deg C, caused in part by waste heat discharge of the Lansing steam power generating plants. This must be taken into account in planning treatment facilities to control stream BOD. (Knapp-USGS)

W69-03077

#### ACCURACY OF DISCRETE MODELS USED TO PREDICT ESTUARY POLLUTION,

Rice Univ., Houston, Tex.

J. V. Leeds.

Water Resources Res, Vol 3, No 2, pp 481-490, 1967. 10 p, 9 fig, 4 ref.

Descriptors: \*Estuaries, \*Path of pollutants, \*Water pollution, \*Mathematical models, \*Digital computers, Water quality, Diffusion, Frequency analysis.

Identifiers: Discrete models.

In the solution of estuary pollution problems, the mathematical model is a partial differential equation, which is often replaced by a set of ordinary differential equations with time as the independent variable. The solution to these equations is taken as the solution of the partial differential equations at points dx apart. A significant problem is to determine the closeness of the solution of the ordinary differential equation to the solution of the partial differential equation, the spacing, and the number of sections. The closeness of the solution can be judged by examining the magnitude and phase of the frequency response of the partial differential equations and the set of ordinary differential equations. Selecting a given phase error allows one to obtain a relation giving the allowed spacing. Selecting an attenuation error sets the number of sections. Thus, from the knowledge of the frequency response of the system the rules developed give the number of sections and spacing to meet specified errors in the approximation.

W69-03107

#### INVESTIGATION OF THE INFLUENCE OF WASTE DISPOSAL PRACTICES ON GROUND-WATER QUALITIES,

South Dakota State Univ., Brookings. Dept. of Civil Engineering.

John R. Anderson, and James N. Dornbush.

Technical Completion Report, Water Resources Institute, November, 1968, Washington, D. C., 41 p, 5 tab, 11 fig, 13 ref. OWRR Project A-003-SDak.

Descriptors: \*Waste disposal, \*Groundwater, \*Water quality, \*Landfill, Sanitary fill, Waste dilution, Water pollution control, Leaching, Water quality control, Domestic wastes, Infiltration, Aquifers, Sanitary engineering.

Identifiers: Brookings (South Dakota).

An evaluation of the effects of its landfill on the groundwater quality was initiated by the city of Brookings, S. D. in 1960, and incorporated in a comprehensive study by this project in 1964. The initial phase of the project concluded that the most useful parameters for detecting contamination were chlorides, sodium and specific conductance with the next phase, concluding that seasonal rainfall intensified leaching. Increased ionic concentrations during rainy periods implied that effects of leaching overrode those attributed to dilution. It appeared that as the water moved downstream from the landfill the quality improved and was suitable as a domestic water supply and for irrigation purposes before it left the landfill area. In as much as it was found that a pond seemed to improve the quality of the degraded groundwater, a trench was constructed to intercept the groundwater as it moved from the fill area. It was shown that chemical constituents that were leached from the refuse were modified by the trench and water quality exhibited an improvement. The trench also modified the concentrations of organic materials and the threshold odor levels. General recommended practices were made for disposing of refuse into abandoned gravel pits located in a region of high water table.

W69-03178

#### A STUDY OF THE SURVIVAL OF BACTERIAL INDICATORS OF POLLUTION IN NATURAL WATERS,

Tennessee Univ., Knoxville. Dept. of Civil Engineering.

James D. Womack.

Termination Report, January 1969, 5 p. OWRR Project A-005-Tenn.

Descriptors: \*Coliforms, \*Enterococci, Fecal streptococci, \*Persistence, Dye tracer studies, Self-purification, Neutral sulfite wastes, False positive coliforms.

Identifiers: Kraft wastes, Indicator organisms, Survival, Death rates.

Several studies related to the survival, persistence, or growth of bacteria associated with fecal pollution have been completed. Regular weekly analyses of the indicator organism concentration in Fort Loudoun Lake have been performed from April 1966 to present. The extension of these populations down stream from the major source of fecal pollution is correlated with a number of water quality parameters. Bacterial populations studied include mainly standard coliforms, fecal coliforms, and enterococci. Some studies relating IMVIC types to survival patterns in natural waters have been made. Survival pattern related to both distance and time-of-flow have been made. A detailed study of the significance of false-positive coliform bacteria using the membrane filter technique was made with the finding that at distances from the polluting source as many as seventy-five percent of those coliforms recovered as coliform may be shown not to ferment lactose to gas. Paper mill effluents of both Kraft and neutral sulfite types have been shown in this study cause growth of coliforms used to estimate water quality. The relative levels of standard coliforms, fecal coliforms, and IMVIC types with the groups have been measured and are presently being evaluated.

W69-03181

#### NUTRIENT SOURCES FOR ALGAE AND AQUATIC WEEDS,

Wisconsin Univ., Madison. Engineering Experiment Station.

George P. Fitzgerald.

In: Detection of limiting or surplus nutrients in algae, 9 December 1968. 21 p. WP - 297.

Descriptors: \*Algae, \*Cycling nutrients, \*Enzymes, \*Essential nutrients, \*Nitrogen cycle, Analytical techniques, Aquatic algae, Aquatic microbiology, Aquatic productivity, Aquatic weeds, Balance of nature, Bioassay, Chlorophyta, Cyanophyta, Environmental effects, Eutrophication, Limnology, Nitrogen compounds, Nitrogen fixation, Nutrient requirements, Phosphorus compounds, Physiological ecology, Phytoplankton, Pollutant identification, Rain, Rainfall-runoff relationships, Rain water, Rooted aquatic plants, Sewers, Water pollution, Water pollution control, Water pollution effects, Water pollution sources.

Identifiers: Lake Mendota (Wis).

Simple bioassays for limiting or surplus nitrogen and phosphorus conditions in algae or aquatic weeds have been used to follow the nutrition of algae and aquatic weeds during summer of 1968. Of particular interest have been the sources of nitrogen and phosphorus available to these plants. It has been shown that during summer rain could be the major source of available nitrogen to Cladophora sp in Lake Mendota, Wis. Increases in phosphorus associated with rainfalls were detected but were not as dramatic as increases in nitrogen. In addition, studies have shown that mixed blooms of planktonic algae do not share their nutrients with other algae even when one species may have a surplus and another be nutrient-limited. Comparisons of surface and subsurface phytoplankton have indicated that at certain times surface plankton could be nutrient-limited while the same species from subsurface sources had adequate or surplus nutrients. Fall overturn as a nutrient source has been used to demonstrate how similar changes

## Effects of Pollution—Group 5C

can occur in the nutrition of different types of algae. The results of these studies are used to point out some of the important factors involved in field studies of the nutrition of aquatic plants.

W69-03185

## 5C. Effects of Pollution

### AN EVALUATION OF ARTIFICIAL SUBSTRATES FOR MEASURING PERiphyton PRODUCTION,

Michigan State Univ., East Lansing. Dept. of Fisheries and Wildlife.

J. C. Peters, R. C. Ball, and N. R. Kevern.

Inst. of Water Research, Technical Report No. 1, Red Cedar River Series, May 1968. 70 p.

Descriptors: \*Diatoms, \*Periphyton, \*Aquatic productivity, \*Streams, \*Rivers, Benthic flora, Biomass, Bioindicators, Chlorophyll, Correlation analysis, Estimating equations, Eutrophication, Michigan, Photosynthesis, Plant pigments, Regression analysis, Seasonal, Sewage, Succession, Water pollution effects.

Identifiers: \*Red Cedar River (Mich), \*Substrates, Cocconeis placentula, Navicula cryptocephala, Gomphonema olivaceum, Cyclotella meneghiniana, Cymbella, Synedra ulna, Melosira virians, Analysis of variance, Covariance analysis, Deer Creek (Mich), Duncan's multiple range test, Eppley pyrheliometer data, Experimental design, Insolation rates, McGinnis index, Spring maximum, Trophodynamics, Vallesneria americana, Williamston (Mich).

Red Cedar River is subject to cultural eutrophication in vicinity of Williamston, Mich. Plexiglass plates (2 in. x 5 in. x 1/4 in.), which proved to be non-selective, were used to sample the aufwuchs community (principally diatoms) at four stations from July 1958 through February 1959. Data derived from substrates were subjected to statistical analysis to determine relationships among the following rates: growth in number of organisms; accumulation of organic matter; accumulation of phytopigments. A site on Deer Creek, a tributary, showed greatest number of dominant communities during study period. Correlation coefficient ( $r$ ) between phytopigment units (PU) and numbers of organisms is highly significant ( $r = 0.75 - 0.90$ ). Although there was good correlation ( $r = 0.93$ ) in the relationship between PU and weight of organic matter, a single regression line could not be used to estimate organic matter from PU for all stations. Compared with main stream, the tributary produced at significantly higher levels during summer. Production immediately downstream from a sewage treatment plant was not greater than for station above the outfall. Productivity of aufwuchs community corresponded closely with insolation rate. No evidence of photo-inactivation of photosynthesis was adduced. Authors presents a series of predictor equations for production and discusses their reliability.

W69-02955

### PRIMARY PRODUCTIVITY STUDIES IN ONONDAGA LAKE, NEW YORK,

Syracuse Univ., N. Y. Dept of Civil Engineering.

Daniel F. Jackson.

For publication in 'XVII Verhandlungen Internationale Vereinigung Fur Theoretische und Angewandte Limnologie', 1968. 19 p. NY Dept. of Health C-19638.

Descriptors: \*Eutrophication, \*Water pollution sources, \*Water pollution effects, \*Primary productivity, Algae, Biomass, Calcium compounds, Chlorides, Saline lakes, Heavy metals, Industrial wastes, Lakes, Photosynthesis, Phytoplankton, Cisco, Carp, Diatoms, Chlorophyta, Chlamydomonas, Chlorella.

Identifiers: \*Onondaga Lake, Onondaga County, Syracuse, Warburg respirometer, Cladophora, Enteromorpha, Lepocinclis, Chlorogonium, Scenedesmus, Cyclotella, Stephanodiscus.

Onondaga Lake, whose south end is within the city limits of Syracuse, NY, is small, brackish, and grossly polluted. It receives daily 200,000,000 liters of partially treated sewage, 172 metric tons of calcium chloride, 32 metric tons of calcium sulfate, one metric ton of grease and oil, and 22 kilograms of heavy metals. To establish a base line for determining extent of eutrophication, author established two stations: I at north end of lake, which is subject to inorganic pollution; and V, a southern station influenced by outfall from a primary treatment sewage plant. Between May and October 1967, monthly determinations were made of algal counts, ash-free dry weights, and respiratory and photosynthetic rates (by Warburg manometry). Phytoplankton was dominated by species of chlorophytes and diatoms; very cyanophytes were counted. Patterns of dominance did not differ between stations. At 1% level of confidence, there were significant differences between stations. As compared with I, values at V were greater in the following (sample numbers in parentheses): (N=3) nitrate-nitrogen, ammonium-nitrogen, phosphates; (N=6) algal numbers, ash-free dry weights; (N=98) photosynthetic rate, respiratory rate. Detailed limnological studies are needed before the expenditure of large sums for pollution abatement projects.

W69-02959

### ADSORPTION OF PHOSPHORUS BY LAKE SEDIMENT,

Connecticut Agricultural Experimental Station, New Haven.

For primary bibliographic entry see Field 02H.

For abstract, see .

W69-03075

### AN INVESTIGATION OF THE EFFECT OF CONTROLLED RELEASES ON THE PHYSICAL, CHEMICAL AND BACTERIOLOGICAL CHARACTERISTICS OF FORT LOUDOUN RESERVOIR,

Tennessee Univ., Knoxville. Dept. of Civil Engineering.

Floyd C. Larson.

Termination Report, June 1968, 5 p. OWRR Project A-006-Tenn.

Descriptors: Reservoirs, Impoundments, \*Stratification, \*Nutrients, Eutrophication, Water quality, Phosphates, Nitrogen.

Identifiers: \*Controlled release effects in reservoirs, Cherokee Lake, Douglas Lake.

Controlled releases from upstream tributary lakes did not prevent stratification in the reservoir. The 'duck-under' point (where stratification begins) varied about six miles, but with extremely large discharge changes it moved about twelve miles in three days. During stratification the oxygen sag curve for the surface was normal, but was not during non-stratified flow periods. An equation was developed for the determination of the coefficient of reoxygenation in a non-stratified flow system. Changes of flows influenced BODs and coliforms in the non-stratified regime but no influence was observed in the stratified regime. Phosphate and nitrogen levels found in the reservoir indicate that conditions are favorable for eutrophication.

W69-03180

### THE PRODUCTIVITY OF A LAKE POLLUTED BY ORGANIC WASTES DERIVED PRIMARILY FROM SEPTIC TANKS,

Tennessee Univ., Knoxville. Dept. of Zoology and Entomology.

Dewey L. Bunting.

Termination Report, June 1968. 14 p, 8 fig, 1 tab. OWRR Project A-008-Tenn.

Descriptors: \*Primary production, \*Eutrophication, \*Septic tanks, Domestic wastes, Water pollution, Photosynthesis, Ponds, Lakes, Drainage, Phytoplankton, Nutrients, \*Oxygen, Diurnal.

Identifiers: \*Production-respiration ratio, Autotrophy, Heterotrophy.

Weekly diurnal studies of oxygen rate-of-change and community metabolism were used to provide estimates of primary productivity in a small homothermal lake receiving organic wastes. These estimates were compared with data from other aquatic habitats. During the study period the production-respiration ratio varied around unity with a tendency toward heterotrophy during the early summer. Evidence is presented to support the assumption that heterotrophy will dominate the summer metabolism. The results of weekly analyses of eleven chemical and physical parameters are presented with a discussion of the relationship of heterotrophy to spring and early summer increases. The application of the study as a basis for the design of future work is discussed with particular reference to the repetition of the present study after completion of a sewer system being constructed in the area around the lake. By comparing the present work and that done after diversion of the wastes, it is anticipated that the contribution of septic tank wastes to the productivity of the lake can be quantified.

W69-03182

### SOME FACTORS IN THE COMPETITION OR ANTAGONISM BETWEEN BACTERIA, ALGAE, AND AQUATIC WEEDS,

Wisconsin Univ., Madison. Engineering Experiment Station.

George P. Fitzgerald.

In: Detection of limiting or surplus nutrients in algae, 9 December 1968. 19 p. WP-297.

Descriptors: \*Algae, \*Algal toxins, \*Aquaria, \*Aquatic weeds, \*Inhibition, \*Physiological ecology, \*Phytotoxicity, Algal control, Algal poisoning, Analytical techniques, Aquatic algae, Aquatic bacteria, Aquatic microbiology, Balance of nature, Bioassay, Chlorophyta, Cyanophyta, Diatoms, Cycling nutrients, Environmental effects, Enzymes, Essential nutrients, Nitrogen compounds, Nuisance algae, Nutrient requirements, Phosphorus compounds, Phytoplankton, Plankton, Pollutant identification, Rooted aquatic plants, Sewers, Sewage, Sewage effluents, Sewage treatment, Water pollution, Water pollution effects, Water pollution sources.

Field observations of changes in the populations of aquatic weeds and phytoplankton have confirmed that aquatic weeds have antagonistic activity against phytoplankton. Nutritional studies in the laboratory indicate that cultures of the aquatic weeds Myriophyllum sp, Ceratophyllum sp, and duckweed (Lemma minor L); liquid cultures of barley (Hordeum vulgare L, Dickson variety); and cultures of the filamentous green algae, Cladophora sp and Pithophora oedogonium (Mont) Withrock will remain relatively free of epiphytes or competing phytoplankton if the cultures are nitrogen limited. Field observations of Cladophora sp have confirmed that the growth of epiphytes on the Cladophora is related to conditions of surplus available nitrogen compounds. It is proposed that this antagonistic activity may be due to a 'nitrogen sink' effect in which the aquatic weeds or filamentous green algae prevent the growth of contaminating algae by competition for the limited nitrogen compounds available. However, the presence of bacteria-sized organisms which have selective toxicity to certain algae indicates that perhaps multiple factors exist. Author discusses the ecological implications, such as nitrogen-limited growth, of associations of certain algae with bacteria having selective toxicities to other algae under certain environmental conditions.

W69-03188

### WATER QUALITY AS RELATED TO THE SURVIVAL OF SALMON EGGS AND LARVAE,

Washington Univ., Seattle. Coll. of Fisheries.

Donald E. Bevan, and Ernest O. Salo.

Washington Water Research Center, Completion Report, August 8, 1968. 76 p, 16 tab, 24 fig, 13 ref. OWRR Project B-004-Wash.

## Field 05—WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5C—Effects of Pollution

Descriptors: \*Chinook salmon, Chum salmon, Washington, Fish diets, Fish reproduction, \*Spawning, \*Fish management.

The Snohomish River watershed, which consists of watersheds of Snoqualmie, Skykomish, and Pilchuck rivers, was surveyed for spawning adult salmon during fall and winter of 1965-66. Index streams were chosen for study of egg and fry survival and rearing potential. Movements of dye in intragravel waters were examined by means of fluorometer. No definite conclusions were drawn; however, techniques for studies of chum fry survival were refined. Preliminary estimates of chum fry survival and gravel quality are available. Chinook salmon from May Creek Hatchery were marked with fluorescent pigment, and one lot was released upstream while another was released in Everett Bay proper. An attempt was made to determine survival rates in Everett Bay in relation to sulfite waste liquor from local pulp and paper mills. Chinook salmon apparently migrated out extremely rapidly and did not use Everett Bay as a feeding or rearing area. A similar experiment was conducted on Elliott Bay with very successful results. Apparently migration pattern through Everett Bay is vastly different from that of chinooks released into Duwamish Complex. (Gladwell-Wash)  
W69-03190

#### STUDIES OF JUVENILE SALMON IN THE NOOKSACK RIVER SYSTEM AND BELLINGHAM BAY<sup>1</sup>

Washington Univ., Seattle. Coll. of Fisheries.

Donald E. Bevan, and Ernest O. Salo.

Washington Water Research Center, Final Report, January 2, 1969. 53 p, 12 tab, 15 fig, 25 ref. OWRR Project B-003-Wash.

Descriptors: Washington, Pacific Northwest U. S., \*Salmon, \*Fish migration, Fishkill, \*Water pollution effects, Fish management, Fish population.

Waters of Bellingham Bay have been studied extensively since 1963 by Fisheries Research Institute and were studied as early as 1957 by other investigators (Wagner, Ziebell, and Livingston, 1957) because of pulp mill wastes they receive and possible effects of these wastes upon fish. Studies of juvenile salmon in Nooksack River system and Bellingham Bay were conducted during 1966 and 1967 with financial assistance from Georgia-Pacific Corp. and federal government and are detailed in this report. Studies of Nooksack River salmon commenced on June 15, 1966 and continued into March 1967. The object was to describe early life history with emphasis on seasonal abundance and natural mortality and growth rates. Coho salmon were studied most extensively because they are most vulnerable to environmental fluctuations from their comparatively long residence in freshwater. Little was known about seasonal mortality rate since it had not been investigated previously. Studies in Bellingham Bay began in March 1967 and continued into June. They were concerned with movement and behavior of juvenile salmon during migration and their distribution in relation to concentrations of sulfite waste liquor, dissolved oxygen, turbidity, salinity, and temperature.  
W69-03191

#### ACTIVITY PATTERNS OF FISH EXPOSED TO TOXIC MATERIAL<sup>2</sup>

Kansas State Univ., Manhattan.

John Cairns, Jr., and Hampton W. Shirer.

Project Completion Report, Kansas Water Resources Research Institute, June 1968. 21 p, 11 fig, 19 ref. OWRR Project A-014-Kan.

Descriptors: Activity patterns, Fish, Toxic material, Waste disposal, Aquatic organisms, Behavior patterns, Sublethal effects, \*Bioassay system, \*Toxicant, \*Swimming behavior, Light beam, Tanks, Zinc, Movement patterns, Goldfish, Golden shiners.

Waste disposal concentrations which merely permit survival of aquatic organisms may not permit them to function properly. Temporary survival of fish and other aquatic organisms is meaningless if they have aberrant behavior patterns, fail to reproduce, have poor growth rates, or are not able to function properly in other respects. Most means of assessing sublethal effects require chronic exposures to the test material and use techniques that require considerable expenditures for equipment, space, and personnel. An inexpensive bioassay system was developed that permitted rapid quantitative study of toxicant-induced changes in swimming behavior of fish by counting lightbeam interruptions in test tanks. The results of this investigation indicated (1) that the apparatus described functioned adequately, (2) sublethal concentrations of zinc altered the movement patterns of the goldfish and the golden shiner, (3) there was considerably more individual variation in movement patterns than in dose-response curves plotting survival against concentration, and (4) a single individual varied in response from time to time. It was evident that many non-lethal concentrations are not safe in the functional sense and bioassay techniques and data are badly needed so that standards and management methods for industrial areas can be developed.  
W69-03194

#### EVALUATION OF THE EFFECT OF TRACE ELEMENTS ON THE ACTIVITY OF MICROORGANISMS<sup>3</sup>

Virginia Polytechnic Inst., Blacksburg. Water Resources Research Center.

Robert E. Benoit.

Virginia Water Resources Research Center, Project Completion Report, August 1968. 5 p, 3 ref. OWRR Project A-005-Va.

Descriptors: \*Microorganisms, \*Trace elements, Water analysis, Streptococcus, Ion exchange.

In this study, a chromatographic procedure was developed which permits the rapid identification of *S. lactis* var. *tardus*. It is possible to prevent a rapid fermenting strain of *S. lactis* from losing this potential, if the water used in the media to cultivate this bacterium is first passed through an anion/cation mixed bed ion exchange column. It was demonstrated that the 'tardus' factor which is responsible for the conversion of fast fermenting strains of *S. lactis* into var. *tardus* strains is present in several watershed systems in southwestern Virginia. The data indicate that the 'tardus' factor is a trace element, but it has not been established which element produces this change. Also, it was demonstrated that *S. lactis* has the genetic potential to produce a number of endproducts in major quantity which were not previously believed possible with this bacterium, which include: acetic acid, formic acid, ethanol, several neutral products, and carbon dioxide. The 'tardus' factor permits the selection of mutant bacteria which are able to become the dominant bacterium in natural systems, producing these products. The results should be useful to any industry that uses microbial fermentation.  
W69-03196

#### SD. Waste Treatment Processes

##### MUNICIPAL CORPORATIONS: SEWER SYSTEMS<sup>4</sup>

N C Gen Stat sec 160-239-160-241, 160-250, 160-255 (1964).

Descriptors: \*Sewers, Municipal wastes, Assessments, \*Eminent domain, Right of way, \*Treatment facilities, Urbanization, Water law, North Carolina, Local governments, Legislation, Cities, Operation and maintenance, Condemnation, State governments, Administrative agencies.  
Identifiers: Liability, Monetary damages.

Section 160-239 provides for the establishment and maintenance of municipal sewage systems. The governing body of the system shall be empowered to extend the system beyond the municipal limits, to condemn property for the system, to provide, construct and maintain the system, and to protect it by regulations. Any conflicts between the general statute and local municipal regulations shall be controlled by the local provisions if the local authorities so desire. Section 160-140 empowers the governing body to require that property owners have various discharge devices on their property connected to the system if lines are close to their property. Section 160-141 provides for assessments against property owners who benefit from the system. Such assessments may be paid in installments but the period of payment shall not exceed 10 years. Section 160-250 allows two or more adjoining municipalities to jointly construct and operate their systems. Section 160-255 empowers municipalities to furnish service within or outside the municipality, but limits liability for failure to provide service to those within the corporate limits. (Dann-Fla)  
W69-02895

#### WASTE WATER RENOVATION FOR REUSE: KEY TO OPTIMUM USE OF WATER RESOURCES<sup>5</sup>

Pennsylvania State Univ., University Park.

William E. Sopper.

Water Res, Vol 2, No 7, pp 471-480, Sept 1968. 10 p, 3 tab, 14 ref.

Descriptors: \*Waste water, \*Reclaimed water, \*Water reuse, Groundwater basins, \*Waste water treatment, Effluents, Optimum use, Forests, Sewage effluents, Sanitary engineering, Industrial wastes, Vegetation, Filters, Aquifers, Water quality, \*Groundwater recharge, Groundwater.

Identifiers: Forestry land, \*Renovating, \*Waste water reclamation.

Treated municipal waste water was applied to forested areas to determine feasibility of land disposal of the effluents and the extent effluents could be renovated by the biosystem and recharged to the ground-water reservoir. Satisfactory renovation of waste water was achieved when the effluent was applied at rates of 1, 2, and 4 in./wk in forested areas during Apr-Nov. The concentration of MBAS (methylene blue active substance), the only constituent in the effluent exceeding the levels acceptable under U S Public Health Standards for potable water, was decreased below this level after passing through the forest floor and 6 in. of mineral soil. The renovation efficiency of forested sites may diminish in time, since many nutrients absorbed by the trees are replaced annually in leaf fall. Approximately 90% of the water applied at 2 in./wk during Apr-Nov was recharged to the ground-water reservoir. Results of this study indicate that municipal waste water can be satisfactorily renovated for ground-water recharge through irrigation of forested areas under controlled conditions. (USBR)  
W69-02929

#### APPLICATION OF THE TOWN OF WATERFORD (VALIDITY OF STREAM CLASSIFICATION)<sup>6</sup>

164 N Y S 2d 914-922 (Sup Ct 1957).

Descriptors: \*New York, Administrative agencies, \*Administrative decisions, Judicial decisions, Water quality, \*Standards, Water pollution, \*Water quality control, Cities, Taxes, Sewage, Municipal wastes, Legislation, Classification, Streams, Legal aspects, Rivers.

Identifiers: \*Stream classification, Mohawk River.

Petitioners, municipalities along the Mohawk River, sought review of a determination by the Water Pollution Control Board assigning a classification of 'C' to the waters on which the cities bordered. Such classification was made pursuant to the

Public Health Law and was part of a program designed to implement standards of quality and purity adopted by the Board. The undisputed result of such classification was that the cities would have to construct sewage treatment facilities. The cities attacked the classification on the grounds that the board had not complied with the correct procedure prescribed by statute and that the Board had not given consideration to the great expense and resultant tax increase for the residents of the cities. The Supreme Court, Appellate Division, held that the anticipated financial burdens were not reasonable grounds for invalidating the classification. Such hardships should be dealt with by legislature. The court stated that, where there were no disputed factual questions, the procedures followed, which did not include swearing of witnesses and cross-examination, were adequate. (Williams-Fla) W69-02990

**REGIONAL MANAGEMENT OF WATER QUALITY - A SYSTEMS APPROACH,** Louisiana State Univ., Baton Rouge; Carnegie-Mellon Univ., Pittsburgh, Pa.; and Harza Engineering Co., Chicago, Ill.  
For primary bibliographic entry see Field 05G.  
For abstract, see .  
W69-03146

**OPTIMAL WASTE TREATMENT AND POLLUTION ABATEMENT BENEFITS ON A CLOSED RIVER SYSTEM,** Toronto Univ., Ontario.  
Donald J. Clough, and M. B. Bayer.  
J Can Oper Res Soc, Vol 6, No 3, pp 153-170, Nov 1968. 18 p, 15 ref.

Descriptors: \*Mathematical models, \*Water pollution control, \*River systems, Multiple-purpose reservoirs, Benefits, Dissolved oxygen, Biochemical oxygen demand, \*Waste water treatment, Economic efficiency, Standards, Constraints, \*Efficiencies.

A nonlinear programming model was used for the selection of an optimal set of waste treatment plant efficiencies on a closed river system. The short-run objective was to minimize the incremental costs of adjusting plant efficiencies to satisfy stream quality constraints (DO and BOD levels) at various points in the system. The long-run objective was to minimize the relevant incremental costs of a sequence of irreversible changes in efficiencies over a finite planning horizon. Stream dilution effects of multipurpose storage reservoirs were also described, and a new basis laid for the measurement of the economic pollution abatement benefits of multipurpose reservoir systems. (Gysi-Cornell) W69-03150

## 5E. Ultimate Disposal of Wastes

**MATHEMATICAL MODEL FOR UNDERGROUND DISCHARGE OF RADIOACTIVE GASES,** Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.  
For primary bibliographic entry see Field 05B.  
For abstract, see .  
W69-02813

**EXPERIENCE IN BURIAL OF LIQUID RADIOACTIVE WASTES IN DEEP GEOLOGICAL FORMATIONS,** F. P. Yudin, M. K. Pimenov, and A. I. Nazarov. translation from Atomnaya Energiya, Vol 25, No 2, pp 128-133, Aug 1968. U S Joint Publication Res Serv, Pub No 46535, 10 p, Sept 26, 1968. 1 fig, 1 tab, 10 ref.

Descriptors: \*Radioactive waste disposal, \*Injection wells, Research and Development, Geohydrologic units, Hydrologic aspects, Economic feasibility.  
Identifiers: \*USSR, \*Hydrogeological conditions, Russian platform (Geologic).

Investigations conducted on the disposal of radioactive wastes by injection wells in lower Carboniferous sandstones of the Russian Platform show that injection is economically feasible on industrial scales under favorable geohydrological conditions. The top of the injection zone is at a depth of 1,432 m and its bottom is at 1,508 m. The formation water has a total dissolved solids content of 245 g/l, mainly of sodium and chloride. The zone has almost no hydraulic connection with overlying aquifers; it is separated from them by a minimum of 40 m of clay. The injection well may be flushed by pumping, and the radioactive water pumped out is filtered and returned to the well. Observation wells are 100, 500, 1300, and 550 m from the injection well. Injection at 100-150 cu m per day for a total of 40,000 cu m did not result in any detected radioactivity at any observation well. (Knapp-USGS) W69-03061

**ROLE OF SOILS AND SEDIMENT IN WATER POLLUTION CONTROL—PART I, REACTIONS OF NITROGENOUS AND PHOSPHATIC COMPOUNDS WITH SOILS AND GEOLOGIC STRATA,** Federal Water Pollution Control Administration, Washington, D. C.  
George W. Bailey.

Fed Water Pollut Contr Admin, Southeast Water Lab Rep, Part 1, 90 p, March 1968. 13 fig, 8 tab, 196 ref.

Descriptors: \*Soil chemical properties, \*Soil physical properties, \*Soil disposal fields, \*Waste water disposal, Industrial wastes, Municipal wastes, Organic wastes, Sewage, Nitrogen, Phosphorus.  
Identifiers: Soil biological properties.

Literature on the reaction, nature, fate, and behavior of nitrogenous and phosphatic compounds in soils and geologic strata was reviewed in relation to the use of soil and geologic strata as a media for municipal and industrial disposal. Principles of soil science are discussed in terms of soil-forming processes, soilphysico-chemical, mineralogical, and biological properties, and their interrelationships. The quantitative and qualitative aspects of nitrogen and phosphorus in both raw sewage and treated effluent are indicated. The mobility of inorganic and organic nitrogen in soils is discussed, as well as the reaction mechanisms by which inorganic forms can be removed from percolating solutions and fixed. The factors affecting fixation, subsequent release, and degradation are also discussed. The immobile nature of phosphorus in soils compared to nitrogen, the generally high phosphorus fixation power of soil, and factors affecting the fixation of phosphorus by soils are discussed. The fixation mechanisms for both inorganic and organic forms of phosphorus are treated in detail. A glossary of soil science terms is included. (Knapp-USGS)  
W69-03080

## 5F. Water Treatment and Quality Alteration

**LONG-TERM CHANGES IN WATER CHEMISTRY AND ABUNDANCE OF PLANKTON AT A SINGLE SAMPLING LOCATION IN LAKE ONTARIO,** Ontario Water Resources Commission, Toronto; and Municipality of Metropolitan Toronto (Ontario). Dept. of Works.  
For primary bibliographic entry see Field 02H.  
For abstract, see .  
W69-02958

## 5G. Water Quality Control

**COMPOSITION OF WATER DISCHARGED FROM BITUMINOUS COAL MINES IN NORTHERN WEST VIRGINIA,** West Virginia Univ., Morgantown.

For primary bibliographic entry see Field 05B.  
For abstract, see .  
W69-02804

**DANIELS V BETHLEHEM MINES CORP (RIPARIAN EASEMENTS).**

391 Pa 195, 137 A 2d 304 (1958).

Descriptors: Judicial decisions, \*Pennsylvania, Legal aspects, Riparian rights, Competing uses, \*Riparian waters, Stock water, \*Water pollution, Reasonable use, Right-of-way, \*Easements, Riparian land, Mine water, Streams, Fouling.  
Identifiers: Covenants running with land.

Plaintiff's grantor had executed a written agreement with defendant's grantor which permitted the latter, an upper riparian owner, to discharge mine water into a stream flowing over the land of plaintiff. The court held that the easement granted in the agreement ran with the land. The language was construed to allow defendant to discharge mine water into the stream, even though this resulted in pollution or fouling of the waters, thus rendering it unfit for plaintiff's cattle. The agreement was neither illegal nor contrary to public policy. (Molica-Fla)  
W69-02858

**NAVIGATION -- BUOYS, BEACONS, FLOODGATES, AND DUMPING MUD OR REFUSE.**

For primary bibliographic entry see Field 06E.  
For abstract, see .  
W69-02870

**TAPPING, INTERFERING WITH, OR DAMAGING SEWERAGE WORKS - RUNNING WATER INTO MINES.**

N J Stat Ann tit 2A, Para 122-5, 122-7 (1968) 2 p.

Descriptors: \*New Jersey, \*Legislation, Water law, Pipelines, Pumping plants, Sewage disposal, Sewers, \*Mining, Channels, Drains, Sewage, Sewage treatment, Legal aspects, Damages.

Any person in the State of New Jersey who unlawfully breaks into, makes connection with, interferes with, or willfully damages any of the facilities of a sewerage company is guilty of a misdemeanor. Also, person who, with intent to hinder or delay the working of any mine, clay pit or marl pit, willfully or maliciously runs water into the mine or pit, or damages any airway, waterway, drain or shaft of the mine or pit is guilty of a misdemeanor. (Watson-Fla)  
W69-02871

**PRIVATE SEWERS.**

N Y Village Law sec 89 (55) (McKinney 1966).

Descriptors: \*New York, \*Legislation, Water law, \*Sewers, Drains, Sinks, Cisterns, \*Pipelines, Financing, Assessments, Legal aspects, Construction, Operation and maintenance.

The officers of a village of the State of New York may regulate and prohibit the construction and use of private sewers, drains, sinks, vaults, and privies. They may also compel the owner or occupant of land upon which is situated any objectionable stable, privy, sewer, drain, cistern, vault, or any unwholesome or nauseous condition to cleanse, remove, or abate the condition. The officers of the village may also compel the owner or occupant of any building or structure to connect with the sewer system of the village. If the owner or occupant fails to comply with the order, the officers may have the connection made and assess the cost upon the land upon which the improvement was made. (Watson-Fla)  
W69-02876

## Field 05—WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5G—Water Quality Control

**BUMBARGER V WALKER (CONTAMINATION OF SPRING BY MINE DRAINAGE).**  
393 Pa 143, 142 A 2d 171-174 (1958).

Descriptors: \*Pennsylvania, \*Mine wastes, \*Water pollution, \*Reasonable use, Judicial decisions, Water law, Damages, Mine drainage, Mine water, Mining, Springs, Drainage, Ditches, Invasion.

Identifiers: Open-pit mining.

Plaintiff, a lower landowner, brought this action to recover damages from persons in charge of an open pit mining operation on upper land which caused the contamination of the plaintiff's spring. The trial court rendered a judgment for the plaintiff. The Supreme Court of Pennsylvania affirmed on the ground that the evidence presented a question for the jury as to whether the contamination was caused by the defendant's discharge of drain water from the mine or some other cause. The operator of an open-pit mine has a right to discharge drainage waters accompanying such an operation in a manner consistent with a reasonable use of the land. The operator is not liable to an adjoining property owner if waters used in the mine's operation reach the other property through some natural watercourse. However, in this case, the mine workers dug a ditch into which they then pumped mining drainage waters that subsequently flowed upon the plaintiff's land, thus contaminating his spring. (Watson-Fla)  
W69-02901

**BOARD OF HEALTH V CREW (STATE'S RIGHT TO ORDER WELL CLOSING).**

212 Md 229, 129 A 2d 115-120 (1957).

Descriptors: \*Maryland, Judicial decisions, \*Water pollution sources, Sewage, Septic tanks, Water pollution control, Administrative agencies, State governments, Water supply, Well permits, Well regulations, \*Shallow wells, \*Public health, Public utilities, Legal aspects, Legislation.

Identifiers: Police power.

Plaintiff owned and lived in a house in a small Maryland community. Each house had its own septic tank. Public water was furnished by a privately owned company. When the water supplied by the water company became impure (it contained excessive iron), plaintiff began to dig a well near certain septic tanks. Plaintiff did not seek any permit for the shallow well. After the digging had begun, state health officials warned that the well would become contaminated and advised that the well would be subject to provisions of a state statute. The statute authorized the State Health Board to order the discontinuance of any well whenever it may have deemed it to be prejudiced to public health. Plaintiff completed the well, and the Health Board ordered the well to be abandoned. At the time of the order, the well water was found to be uncontaminated. Plaintiff brought suit to set aside the order and to enjoin enforcement. The lower court vacated the order, but the appellate court reversed. The higher court ruled that action taken for protection of the public health is not required to be postponed until contamination is shown to exist. The order was a constitutional exercise of state's police power. The court noted that the impure condition of the public supply was later corrected. (Wheeler-Fla)  
W69-03024

**WATER POLLUTION RESEARCH 1967.**  
Water Pollution Research Steering Committee, London (England).

Water Pollut Res Pub Annu Rep, 1967, 213 p, 1968. 77 fig, 4 plate, 40 tab, 6 append.

Descriptors: \*Water pollution, \*Water pollution control, \*Water pollution effects, \*Water pollution sources, Water pollution treatment, Industrial wastes, Municipal wastes, Sewage treatment, Disposal, Estuaries, Streams, Chemical analysis, Fish, Bacteria.

Identifiers: Water Pollution Research Laboratory (England).

The result of work at the Water Pollution Research Laboratory in 1967 are reported. Topics studied include coastal pollution, estuaries, freshwater streams, effects of pollution of fish, aerobic biological treatment processes, activated sludge process, percolating filters, sludge treatment, sewage, industrial waste waters, microbiology, methods of chemical analysis, and instrumentation. Lists of papers published by the Water Pollution Research Laboratory, reports of Laboratory work published in scientific journals, and reports of work sponsored by the Laboratory are included. (Knapp-USGS)  
W69-03065

**SIGNIFICANCE OF NITRIFICATION IN STREAM ANALYSIS-EFFECTS ON THE OXYGEN BALANCE,**  
Michigan Water Resources Commission, Lansing.  
For primary bibliographic entry see Field 05B.  
For abstract, see .  
W69-03077

**THE HYDROLOGIC REGIME DUE TO SPRINKLER IRRIGATION OF TREATED MUNICIPAL EFFLUENT ON SLOPING LAND,**  
Pennsylvania State Univ., University Park. Dept. of Agricultural Engineering.

Ernest C. Rebuck.  
Penn State Grad Sch Thesis, Dec 1967. 53 p, 12 fig, 14 tab, 24 ref.

Descriptors: \*Irrigation effects, \*Hydrologic data, \*Waste water disposal, Sprinkler irrigation, Regimen, Runoff, Pressure head, Hydrographs, Agricultural engineering, Water management (Applied).

Identifiers: \*Effluent irrigation.

Data are presented that relate the changes in the hydrologic regime and the amount of effluent irrigation applied to a small experimental plot. Effluent was applied by successively increasing amounts during three 6-week cycles. Changes in the hydrologic regime were determined from outflow hydrographs and piezometer responses. Outflow amounts and piezometer peak heads were highest during the early spring cycle and lowest during the summer cycle. The fall cycle produced responses intermediate between the other two. Outflows tended to increase with amount of application for all cycles. Piezometer peak heads showed pronounced increases for lower amounts of effluent application. Peak heads were similar for larger application amounts, and appeared to be more dependent on antecedent soil moisture conditions than on actual irrigation amounts. (Steinbiber-USGS)  
W69-03109

**MATHEMATICAL MODELS FOR EXPRESSING THE BIOCHEMICAL OXYGEN DEMAND IN WATER QUALITY STUDIES,**  
Iowa State Univ., Ames.

Merwin D. Dougal, and E. Robert Baumann.  
Proceedings of the Third Annual American Water Resources Conference (American Water Resources Association: Urbana, Ill), c 1967, pp 242-253. 12 p, 4 tab, 13 ref.

Descriptors: Model studies, Water equality, \*Mathematical models, \*Biochemical oxygen demand, Impaired water quality, Oxidation, Oxygen demand, Forecasting, Wastes.

Identifiers: \*Monomolecular model, Modified monomolecular model, Second order model.

The development and application of the widely used monomolecular model for biochemical oxygen demand (B.O.D.) is reviewed. Results of laboratory B.O.D. studies are used to reveal that the monomolecular model fails to satisfy its fundamental assumptions. Temporal variations in the

rate constant and the ultimate B.O.D. value are explored for three types of cases: (a) raw domestic sewage, (b) final effluents from waste treatment processes, and (c) contents of an agricultural waste lagoon. Two different models for B.O.D. are presented which statistically are superior to the monomolecular model. These models may be useful in future studies of stream water quality and in the determination of stream assimilative capacities. (Winn-Rutgers)  
W69-03138

#### REGIONAL MANAGEMENT OF WATER QUALITY - A SYSTEMS APPROACH,

Louisiana State Univ., Baton Rouge; Carnegie-Mellon Univ., Pittsburgh, Pa.; and Harza Engineering Co., Chicago, Ill.

Melvin W. Anderson, and H. J. Day.  
J Water Pollut Contr Fed, pp 1679-1687, Oct 1968. 9 p, 4 fig, 1 tab, 8 ref.

Descriptors: Stream improvement, \*Waste water treatment, \*Linear programming, Simulation analysis, Regional analysis, \*Decision making, Biochemical oxygen demand, Dissolved oxygen, Optimization, Municipal wastes, Industrial wastes, River basins, \*Water policy, Public benefits, Standards, Oxygen sag.

Identifiers: Miami River, Ohio, \*Regional management, Dayton.

A linear programming model combined with simulation of hydrologic data was used to compare five waste treatment policies for the Miami River below Dayton, Ohio, in order to determine the minimal regional operating costs while trying to maintain river quality (DO) standards. An oxygen sag model for the river was developed using a modified Streeter-Phephs equation. 400 years of streamflow were generated from the 51-year existing record. It was assumed that monthly treatment (BOD removal) could be varied uniformly between 45 to 90 at each plant, and that cost was a linear function of treatment. The 5 policies tested assumed max and min levels of possible treatment. Results for the study were plotted, showing percent of time standards were violated, extent of violations in critical month, and monthly treatment costs. It was concluded that a regional authority could bring about improved river quality at present treatment costs. (Gysi-Cornell)  
W69-03146

**STREAM RESPONSES AND SYSTEM ANALYSIS IN WATER QUALITY MANAGEMENT,**  
Oklahoma Univ., Norman.

For primary bibliographic entry see Field 06A.  
For abstract, see .  
W69-03159

**SYSTEMS ANALYSIS AND SIMULATION IN WATER QUALITY MANAGEMENT,**  
Manhattan Coll., Bronx, N. Y.

Robert V. Thomann.  
Proc, IBM Sci Comput Symp Water Air Resource Manage, Thomas J. Watson Research Center, Yorktown Heights, N. Y., pp 223-233, Oct 1967. 11 p, 4 fig, 7 ref.

Descriptors: \*Systems analysis, \*Simulation analysis, \*Water quality, Analytical techniques, \*Input-output analysis, Streamflow improvement, Water management (Applied), Estuaries, Dissolved oxygen, Time series analysis, Mathematical models.  
Identifiers: Delaware Estuary.

Several aspects of systems analysis and simulation in the management of water quality in a time-variabile sense were presented. The dissolved oxygen of a stream or estuary was used as the primary indicator of water quality. The basic equations that describe the time variability of dissolved oxygen in the stream or estuary were presented first. This was followed by an analysis of the problem of determining the variance of dissolved oxygen at downstream locations due to a stochastic waste load input.

## Techniques of Planning—Group 6A

Finally, some results of a relatively large scale simulation of the Delaware Estuary were presented and some new problems of system verification were discussed. (Gysi-Cornell)  
W69-03161

**RESULTS FROM A SYSTEMS ANALYSIS APPROACH TO THE OPTIMUM CONTROL OF ESTUARINE WATER QUALITY,**  
Federal Water Pollution Control Administration, Philadelphia, Pa.

Robert V. Thomann, and David H. Marks.  
Advances Water Pollut Res, Vol 3, pp 29-48, Proc Third Int Conf, Int Ass Water Pollut Res, Munich, Sept 1966. 20 p, 6 fig, 4 ref, 3 dics.

Descriptors: \*Linear programming, \*Water quality control, \*Estuaries, Optimization, Dissolved oxygen, Standards, Constraints, Wastewater treatment, Water policy, Decision making, Aeration, Diffusion, Digital computers.  
Identifiers: Delaware Estuary, Least-cost treatment, Uniform treatment, \*Sensitivity analysis.

A parametric linear programming analysis checked the effect of various estuarine and wastewater treatment conditions on the water quality (DO) levels in the Delaware Estuary. The model of the physical environment was presented and discussed. This model was one of the principal inputs of the optimization model. The least cost solutions were determined for various ranges of reaeration and diffusion coefficients, and DO standard levels. The uniform-treatment solutions were graphed and discussed. It was concluded that the model was more sensitive to the reaeration coefficient than the diffusion coefficient and that the difference in least-cost and uniform solutions was a valuable guide to policy decisions. Three discussions followed the report. (Gysi-Cornell)  
W69-03162

**DESIGN SENSITIVITY OF POLLUTION CONTROL RESERVOIRS,**  
Federal Water Pollution Control Administration, Washington, D. C.

George K. Young, Roland W. Schrecongost, and William N. Fitch.  
Proc Amer Soc Civil Eng, Vol 94, No SA5, pp 829-840, Oct 1968. 12 p, 2 fig, 4 tab, 11 ref, 2 append.

Descriptors: Oxygen sag, Reservoir design, Streamflow improvement, Waste dilution, Waste water treatment, \*Low-flow augmentation, Dissolved oxygen, Standards, Synthetic hydrology, Simulation analysis, Mathematical models, Decision making, Water policy, Hydrologic data, Routing.  
Identifiers: \*Sensitivity analysis, Kanawha River.

The sensitivity of the 'central design' of a low-flow augmentation reservoir to changes in parameter values used for the study was investigated. Two models were used to obtain the central design. A DO model was used to determine the effect of 3 levels of waste treatment on Kanawha River. For each level of treatment, augmentation of the river flow was increased until the required standard of 4 MG/l DO was met. These required flows were used as inputs to a hydrologic routing model which made the required releases when possible for each of several tried reservoir volumes. The 26-year historic flows were used to obtain the central design (required releases met 90% of time). 20 synthetic 26-year records were generated, and the solution repeated. The same central design resulted. Parameter sensitivity studies were performed on deoxygenation and reaeration rates, waste loading rates, DO standards, and stream velocity. Results of these studies are tabled and discussed. (Gysi-Cornell)  
W69-03163

**A PROPOSAL FOR A SYSTEMS ENGINEERING STUDY OF WATER POLLUTION ABATEMENT,**  
Johnson (Bernard) Engineers, Inc., Houston, Tex.  
Bernard G. Johnson.

Consult Eng, Vol 30, No 3, pp 185-189, Mar 1968. 5 p, 5 fig.

Descriptors: \*Water pollution control, \*Systems analysis, Linear programming, Simulation analysis, Hydraulic models, River basins, Water resources development.

Identifiers: Galveston Bay, Texas.

The techniques and approach to a water pollution abatement study of the Galveston Bay area were outlined. The study area, planning goals, and the makeup of the study team were described. The project approach, including the use of linear programming, simulation analysis and hydraulic modelling were discussed. The equipment available for the study was listed. (Gysi-Cornell)  
W69-03164

**A STUDY IN THE ECONOMICS OF WATER QUALITY MANAGEMENT,**  
Federal Water Pollution Control Administration, Washington, D. C.

Edwin L. Johnson.

Water Resources Research, Vol. 3, No. 2, pp 291-305, Second Quarter 1967, 15 p, 2 fig, 9 tab, 3 ref.

Descriptors: \*Effluents, \*Water quality, Waste disposal, \*Use cost allocation, Water management, Water resource development, Water resource planning, Estimated benefits, Estimated costs, Regional analysis.

Identifiers: Delaware Estuary Study.

The study attempts to estimate the charge required to attain specific levels of water quality, investigate the relation of the charge level to industrial output, and compare the effluent charge method with other methods of pollution control. The physical model employed is a linear steady-state version of a dynamic waste system developed in the Delaware Estuary Study. Input data consists of a matrix relating the effect on (DO) level in each reach to a unit removal of oxygen-demanding material in another reach and a piecewise linear cost function showing the waste removal cost of each discharger. The findings of the study indicate that effluent charges should be considered as a method of improving water quality and that of waste treatment using the effluent charge method is approaching the least costly treatment plan. The study does not find evidence for regional economic effects from the charge level. The Charge method is preferred to conventional methods because it attains the same goal at lower cost, is more equitable and effective and provides a guide to public investment decisions. Further study is needed in problems of differential charges, prediction of induced responses, and administrative performance and cost. (Abodeely-Chicago)  
W69-03173

**ADSORPTION OF PESTICIDES ON EARTH MATERIALS,**  
Massachusetts Univ., Amherst.

John H. Baker.

Water Resources Center, Project Completion Report, August 1968. 14 p, 2 tab, 12 fig, 7 ref. OWRR Project A-019-Mass.

Descriptors: Atrazine, Diazinon, Soils, Leaching, Adsorption, Pesticides.

Atrazine adsorption by soils was independent of CaCl<sub>2</sub> concentration in the range of concentration to be expected in soil solutions but increased as equilibration time increased up to about 10 hours after which time the amount of atrazine adsorbed by the soils after 24 hours of equilibration was found to be dependent on atrazine concentration, soil pH and soil organic matter content. The linear regression equation relating the distribution coefficient for atrazine adsorption to the organic matter content of 25 soils was found to be  $K_d = 0.85\% O.M. - 0.2$ . The correlation coefficient was 0.91. Although the distribution coefficient for atrazine adsorption was independent of soil to solution ratio when this ratio was varied from 0.1 to 1 the adsorp-

tion of atrazine by surface soils was not completely reversible. Atrazine was found to leach in soil columns but was eluted from columns of the two soils tested with less water than predicted using chromatographic theory and the distribution coefficient for atrazine adsorption by the soils measured after 24 hours of equilibration. The linear regression equation relating the distribution coefficient for Diazinon adsorption to the organic matter content of 11 soils was found to be  $K_d = 1.2\% O.M. + 0.2$ . The correlation coefficient was 0.93. Diazinon was more strongly adsorbed than Atrazine by soils.  
W69-03192

**06. WATER RESOURCES PLANNING**

**6A. Techniques OF Planning**

**HYDROLOGIC FORECASTS, PREDICTION PERIODS, RELIABILITY AND EXPERIENCE USING THEM IN WATER RESOURCES SYSTEMS,**  
Ye. G. Popov.

Soviet Hydrol Selec Pap (AGU), No 3, pp 297-303, 1967. 7 p, 3 tab.

Descriptors: \*Forecasting, \*River forecasting, \*Streamflow forecasting, Routing, Low flow, Peak discharge, Floods, Ice, Ice breakup, Freezing, Navigable rivers, Reservoirs.

Identifiers: \*USSR hydrological forecasts.

The hydrological forecasts available in the USSR are reviewed and their uses are listed. The types available are long range water and ice regime forecasts, short range forecasts including dangerous phenomena, hydroelectric power riverflow forecasts, high-water level forecasts, runoff predictions for mountain rivers for irrigation projects, predictions of minimum levels of navigable rivers, predictions of dates of freeze and breakup of rivers and reservoirs, and short-range water level predictions issued during high water periods, floods, and low water. (Knapp-USGS)  
W69-02802

**OPTIMIZATION OF THE OPERATION OF A MULTIPURPOSE RESERVOIR BY DYNAMIC PROGRAMMING,**  
California Univ., Los Angeles.

Warren A. Hall, William S. Butcher, and Austin Escobee.

Water Resources Research, Vol. 4, No. 3, 1968, pp 471-479, 3 fig, 4 ref.

Descriptors: Optimum development plans, Project planning, Multipurpose projects, \*River basin planning, Water resource development, Hydroelectric power, \*Dynamic programming, Linear programming, \*Formulation.

Identifiers: Shasta Dam, Keswick afterbay, Sacramento River.

A technique of analysis is presented by which dynamic operation policies for planning complex reservoir systems producing hydroelectric power and providing water can be optimized for the maximum return from firm water, firm power, dump water, and dump power. The technique provides for complex constraints, such as mandatory flood control reservations variable in time, fish, wildlife and recreational releases, navigation minimum flows, as well as evaporation losses and inter-basin diversions. This paper presents in detail the operational analysis of a component reservoir-river system and the procedure to be used to combine optimally a number of such subsystems into a coordinated mutually reinforcing, multiple system. (Gargola-Chicago)  
W69-02842

## Field 06—WATER RESOURCES PLANNING

### Group 6A—Techniques of Planning

**FORMAL MODELS IN THE DESIGN OF WATER RESOURCE SYSTEMS,**  
Harvard Univ., Cambridge, Mass. Harvard Water Program.  
Robert Dorfman.  
Water Resource Research, Vol. 1, No. 3, 1965, pp 329-337, 5 ref.

Descriptors: Attitudes, Computer models, \*Water resource management, Simulation models, Computer programming, Analytic techniques, Mathematical models, Optimum development plans, \*Decision-making, Stochastic processes, \*Formulation, River basin planning.  
Identifiers: Water resource design, Harvard Water Program.

New methods for designing water resource systems are being evolved as part of a general social tendency toward expressing social problems in the formal modes that have been restricted to scientific and engineering problems. Two general types of models have been fruitful in the field of water resource development: the simulation model and the analytic model. In simulation models temporal sequences of events are reproduced on electronic computers on a time scale in which minutes represent decades, leading to convenient estimates of the consequences of design decisions even in complicated circumstances. In analytic models, consequences are expressed as explicit mathematical functions of design variables. Simulations are awkward when a wide range of design decisions have to be evaluated. Analytic models cannot be applied to practical problems without drastically simplifying them. But the two methods can be used in tandem, with analytic models delineating the range within which simulation is required. (Gar-gola-Chicago)  
W69-02846

**THE FUNCTION OF FEASIBILITY REPORTS,**  
Tudor Engineering Co., San Francisco, Calif.  
Louis W. Riggs.  
Consult Eng, Vol 31, No 3, pp 120-125, Sept 1968. 6 p, 5 fig.

Descriptors: \*Feasibility studies, Project planning, Planning, Project feasibility, Technical feasibility, Feasibility, \*Consulting engineers, Economic feasibility, Financial feasibility, Investigations, \*Reports.

A feasibility report surveys the need for action, proposes a specific response, and evaluates the probable economic results. The feasibility report is neither a planning document nor a preliminary design analysis, but may incorporate these elements. For example, where a comprehensive general plan exists, reexamining assumptions and testing forecasts are often appropriate before making new public commitments. Occasionally, a prospective project demands a large measure of technical innovation so that the design approach must be explored in depth. In every instance, a feasibility report presumes a problem at hand or an opportunity in mind. Although the consulting engineer is helpful in isolating the problem and crystallizing the opportunity, excellent ideas often are found closest to the problem and within the agency staff. The consulting engineer will procure these ideas, add his own perspectives, and develop a plan of analysis. He will then formulate a plan of action, test it against other alternatives, and present his conclusions and judgments. Functions essential to every feasibility report are defined in this process. (USBR)  
W69-02910

**SYSTEMS APPROACH TO WATER QUALITY IN THE GREAT LAKES.**  
For primary bibliographic entry see Field 02H.  
For abstract, see .  
W69-03059

**REGRESSION MODELS FOR PREDICTING ON-SITE RUNOFF FROM SHORT-DURATION CONVECTIVE STORMS,**  
Agricultural Research Service, Tucson Ariz. Southwest Watershed Research Center.  
H. A. Schreiber, and D. R. Kincaid.  
Water Resources Res, Vol 3, No 2, pp 389-395, 1967. 7 p, 1 fig, 4 tab, 6 ref.

Descriptors: \*Rainfall-runoff relationships, \*Thunderstorms, \*Regression analysis, Vegetation, Trees, Soil moisture, Runoff, Surface runoff, Sub-surface runoff, Hydrographs, Histograms, Hyetographs, Arizona, Watersheds (Basins).

Identifiers: Walnut Gulch Experimental Watershed.

On-site runoff resulting from summer convective thunderstorms was studied in the Walnut Gulch Experimental Watershed, Arizona, using 6- by 12-ft plots at 2 locations, based on 5 location-years of data from 34 storms. Average runoff increased as precipitation quantity increased, decreased as crown spread of vegetation increased, and decreased as antecedent soil moisture increased. In a stepwise multiple linear regression equation, these independent variables accounted for, respectively, 72, 3, and 0.5% of the prediction variance. Considering regression equations for any one location-year, storm amount or intensity always was significant, crown spread usually was significant, and antecedent soil moisture rarely was significant. In simple correlations, antecedent soil moisture was never related significantly to runoff. The equations developed appear valid for a set of thunderstorms with at least one-sixth of maximum 5-min intensities exceeding 3.7 in. per hr.  
W69-03103

**SOME ERROR PROPERTIES OF SEGMENTED HYDROLOGIC FUNCTIONS,**  
Georgia Inst. of Tech., Atlanta.  
For primary bibliographic entry see Field 07C.  
For abstract, see .  
W69-03105

**A LAPLACE TRANSFORM PROOF OF THE THEOREM OF MOMENTS FOR THE INSTANTANEOUS UNIT HYDROGRAPH,**  
Technion Israel Inst. of Tech., Haifa.  
M. H. Diskin.

Water Resources Res, Vol 3, No 2, pp 385-388, 1967. 4 p, 1 fig, 3 ref.

Descriptors: \*Hydrograph analysis, \*Unit hydrographs, \*Mathematical studies, Floods, Streamflow, Hyetographs, Runoff, Surface runoff.  
Identifiers: Moment equations, Laplace transforms.

Laplace transforms are used to derive a general relationship for the moments about the origin of the three functions that appear in the convolution integral. The resulting equation can be used for the successive evaluation of the unknown moments of the instantaneous unit hydrograph from the known moments of the rainfall excess hyetograph and of the direct surface runoff hydrograph. Simplified forms of the moments equations are given for the moments of lowest orders.  
W69-03120

**SYSTEMS APPROACH TO WATER RESOURCE MANAGEMENT.**  
TRW Systems Group, San Bernardino, Calif. Resource Management Dept.

Res Activity Rep, Vol 2, 63 p, April 1968. 8 fig, 5 append. OWRR No 14-01-0001-1579.

Descriptors: \*Systems analysis, \*Water resources, \*Municipal water, \*Water management (Applied), Administration, Planning, Methodology, Social aspects, Economics.  
Identifiers: Santa Ana River (California), Alternative solutions.

The systems approach was used to model the management process for urban water resources using the upper Santa Ana River watershed, California, as a source of data for the model and for testing hypotheses. The systems approach used was intended to survey the entire problem in context with the physical, social, and economic forces involved, to recognize dynamic relationships of parts to the whole, and use a multiple-disciplinary method of study. Published reports were used to compile hydrological data for the Santa Ana Basin. Interviews and questionnaires gathered social, economic, and management data. A management handbook describes methods for gathering sufficient information to make decisions and the methods to arrive at and check for correct decisions. Systems management study methods and some applications of systems methods to water resources needing study are outlined, and plans for such studies are presented. (Knapp-USGS) W69-03122

**SOME EVIDENCE ON THE SMALL SAMPLE PROPERTIES OF DISTRIBUTED LAG ESTIMATORS IN THE PRESENCE OF AUTOCORRELATED DISTURBANCES,**  
Carnegie Inst. of Tech., Pittsburgh, Pa.  
Thomas J. Sargent.  
Rev Econ and Stat, Vol XLX, No 1, pp 87-95, February 1968. 9 p, 14 tab, 15 ref.

Descriptors: Least squares method, Monte Carlo method.  
Identifiers: \*Distributed lag, Small sample properties, Autocorrelated disturbances, Estimators, Three pass least squares.

The paper presents Monte Carlo results for several estimators for a simple geometrically declining lag scheme with an infinite tail. The estimators studied include: least squares applies to the autoregressive form of the model, three pass least squares, an instrumental variable technique, a scheme for iterating on a serial correlation parameter, and Klein's maximum likelihood technique which deals directly with the distributed lag form of the model. It is found that the ranking of the estimators depends to some extent on where one is in the parameter space and on the serial properties of the disturbances. Overall, the iterative technique and Klein's method out-perform the others. (Loeb-Rutgers) W69-03124

**A FUNCTIONAL APPROACH TO PROBLEMS OF WATER RESOURCE DEVELOPMENT AND WATER USE,**  
Nevada Univ., Reno.  
H. Clay Little.  
Proceedings of the Third Annual American Water Resources Conference (American Water Resources Assn; Urbana, Ill), c 1967, pp 664-669. 6 p.

Descriptors: \*Water resource development, Water utilization, Decision making, Planning.  
Identifiers: \*Functional approach.

The functional approach is a method of bringing various technical skills to bear upon resource related problems in a comprehensive and systematic manner by directing attention to the uses made of the resource. Keys to the effective use of this approach are (1) problem identification, (2) building the research model around uses made of the resource, and (3) cooperation and communication between individuals in different professions due to the number of interrelationships of use involved and the length of time required between beginning work and producing a proposed solution. (Winn-Rutgers) W69-03134

**APPLICABILITY OF REMOTE SENSING AND SYSTEMS ANALYSIS TECHNIQUES TO RIVER BASIN PLANNING,**  
Purdue Univ., Lafayette, Ind.

M. F. Baumgardner, R. B. MacDonald, L. F.

Huggins, and R. M. Peart.

Proceedings of the Third Annual American Water Resources Conference (American Water Resources Assn; Urbana, Ill.), c 1967, pp 456-465. 10 p, 3 fig, 2 chart, 6 ref.

Descriptors: \*River basin development, Planning, \*Remote sensing, \*Systems analysis, Model studies, Data processing.

Identifiers: Mathematical simulation, Remote multispectral scanning, Laboratory for Agricultural Remote Sensing, Purdue University.

The general problem of formulating plans for the development of all the resources of a large river basin is extremely complex. The techniques of systems analysis and mathematical simulation offer a rational approach to solving these problems. Not all of the technical capability required to implement these techniques on a large scale watershed is currently available. Suitable mathematical models are not available for many of the subsystems outlined in a flow diagram. However, research on the development of suitable component models and on the automatic data acquisition systems capable of economically providing the vast quantities of data essential to such models is rapidly making such studies feasible. (Winn-Rutgers)

W69-03145

#### OPTIMIZATION BY DYNAMIC PROGRAMMING OF HYDROELECTRIC PLANT OPERATION REGIME DURING INITIAL FILLING PERIOD OF MULTIANNUAL REGULATION RESERVOIR,

D. N. Korobova.

Translation from Gidrotekhnicheskoe Stroitelstvo, No 5, pp 35-38, May 1968. Hydrotechnical Construction, No 5, pp 421-425, May 1968. 5 p, 7 ref.

Descriptors: \*Dynamic programming, \*Reservoir operation, Mathematical models, \*Hydroelectric plants, Reservoir construction, River regulation, Economic efficiency, Constraints.

Identifiers: Siberia, USSR, Reservoir filling.

Using dynamic programming, a system of rules for reservoir releases during the initial filling period were determined, given the system firm energy demand, the plant capacity, the non-power required releases, and assuming that long-term flow forecasts were not available. The method assumed that the length of the filling period and final volume were known. The object was to minimize the expenses to the power system during the filling period. Navigation and irrigation constraints placed limits on the possible ranges of reservoir levels each year. An example of the technique was applied to a group of Siberian hydroelectric plants. (Gysi-Cornell)

W69-03155

#### THE LEONTIEF INPUT-OUTPUT SYSTEM AND ITS APPLICATION TO ANALYSIS AND PROJECTION FOR WATER RESOURCES PLANNING,

California Univ., Berkeley.

Everard M. Lofting.

Proc, IBM Sci Computing Symp Water Air Resource Manage, Thomas J. Watson Res Center, Yorktown Heights, N. Y., pp 291-315, Oct 1967. 25 p, 59 ref, 1 append.

Descriptors: Analytical techniques, \*Data collections, Input-output analysis, \*Leontief Models, Planning, \*Water resources development, Regional analysis, Industrial water, Productivity, Interstate, \*Water requirements, \*Economic prediction, Interstate, Planning.

Identifiers: Multiregional analysis, National economy, Interindustry, Water content matrix.

The background and theory of Leontief input-output models for the purpose of projecting regional or national water requirements for the future was presented. A brief history of the development of systems analysis in water resources planning, with

emphasis on input-output methods was given. An interindustry water content Leontief model was developed illustrating the similarities between a general linear programming system and the Leontief system. Present methods of water use data and productivity accounting data collections were discussed, and the possible adaptations of this data to productivity estimates for water requirements suggested. It was proposed that regional water-content matrices for economic projection purposes could then be translated from these estimates. (Gysi-Cornell)

W69-03156

#### THE INTERINDUSTRY WATER CONTENT MATRIX: APPLICATIONS ON A MULTIREGIONAL BASIS,

California Univ., Berkeley.

Everard M. Lofting, and H. Craig Davis.

Water Resources Res, Vol 4, No 4, pp 689-695, Aug 1968. 7 p, 25 ref.

Descriptors: Analytical techniques, \*Data collections, Input-output analysis, \*Leontief Models, Planning, \*Water resources development, \*Regional analysis, Industrial water, Industrial production, Interstate, Decision making, Water requirements.

Identifiers: Western states, Multiregional analysis, Interindustry, Water content matrix.

The applicability of a 'water content' matrix (based on the 'Leontief' or 'input-output' system) for regional planning studies of future interindustry water requirements was discussed. An interindustry or input-output model represents the structural interdependence of a regional economy. The inverse matrix ('factor content' matrix) of the model reveals the amount (dollars, man-hours, acre-feet) of a given commodity necessary for a unit output of a product to final demand. Some of the specific uses of a water content matrix constructed from a western states multiregional input-output model and a vector of water use coefficients were discussed. Suggestions for improvement of present water use data and future data collections, and the applicability of these data to regional water planning were made. (Gysi-Cornell)

W69-03157

#### WATER QUALITY ANALYSIS OF THE DELAWARE RIVER ESTUARY,

Manhattan Coll., Bronx, N. Y.; and Hydroscience, Inc., Leonia, N. J.

Donald J. O'Conner, John P. St. John, and Dominic M. DiToro.

Proc Amer Soc Civil Eng, Vol 94, No SA6, pp 1225-1252, Dec 1968. 28 p, 11 fig, 2 tab, 16 ref, 2 append.

Descriptors: Low-flow augmentation, Nitrification, \*River basin, \*Waste water treatment, Streamflow improvement, Biochemical oxygen demand, Dissolved oxygen, \*Water quality control, Estuaries, Mathematical models, Data collections, Standards, Analytical techniques.

Identifiers: Delaware River, Sensitivity analysis, Basin-wide collection.

A mathematical model was developed for the Delaware River which assesses the efficiency of various proposals for water quality improvement. The analysis highlighted the importance of nitrification in the river that may become intensified by future reduction in carbonaceous demand due to increased treatment. It also indicated good correlation of observed DO distributions assuming oxidation of carbonaceous BOD to be the only active demand on the winter system. The system sensitivity analysis indicated that low-flow augmentation did not appear feasible for increasing DO levels, but demonstrated a pronounced effect between waste loading location and water quality. It was concluded that basin-wide collection and treatment facilities with downstream disposals may be a practical alternative. (Gysi-Cornell)

W69-03158

#### STREAM RESPONSES AND SYSTEM ANALYSIS IN WATER QUALITY MANAGEMENT,

Oklahoma Univ., Norman.

George W. Reid.

Water and Wastes Eng, Vol 5, No 3, pp 56-59, Mar 1968. 4 p, 2 fig, 3 tab.

Descriptors: \*Water quality control, Water management (Applied), Water resources development, Water policy, Decision making, \*Linear programming, Standards, Constraints, Stream improvement, River basins, River basin commissions, Damages, Mathematical models, Public benefits.

A basin-wide approach to water quality control using linear programming techniques was proposed as a feasible method of dealing with increased future demands on river systems. It was suggested that present independent treatment of waste or uniform standards may not be possible under future conditions. A hypothetical example illustrated how a basin-wide linear programming model could be used to find optimal (least-cost) treatment solutions. (Gysi-Cornell)

W69-03159

#### OPTIMIZATION OF TIDAL POWER GENERATION,

M. C. Swales, and E. M. Wilson.

Water Power, Vol 20, No 3, pp 109-114, Mar 1968. 6 p, 11 fig, 2 ref.

Descriptors: \*Optimization, \*Tidal powerplants, Hydroelectric power, Economic efficiency, \*Hydraulic design, Digital computers, Mathematical models, Comparative benefits, Sluicegates, Hydraulic turbines.

Identifiers: Knik Arm, Alaska, Design head.

A method for determining the optimum design of an ebb-generation tidal power station was presented. The method required partial enumeration of alternatives in the searching technique and hence a computer program was used to solve the large number of computations. The equations for a specific design operating on a sinusoidal tide were developed, and the procedure for optimization of operation conditions of the plant were outlined. The optimization of design then followed a specific enumeration procedure, with some alternatives eliminated because of engineering considerations, and others from the graphical analysis of results. For analysis, the 'single-tide method' was used (i.e. energy generation for single tides multiplied by histogram values gave annual energy figures). Results for the Knik Arm, Alaska station were shown. (Gysi-Cornell)

W69-03160

#### SYSTEMS ANALYSIS AND SIMULATION IN WATER QUALITY MANAGEMENT,

Manhattan Coll., Bronx, N. Y.

For primary bibliographic entry see Field 05G.

For abstract, see .

W69-03161

#### RESULTS FROM A SYSTEMS ANALYSIS APPROACH TO THE OPTIMUM CONTROL OF ESTUARINE WATER QUALITY,

Federal Water Pollution Control Administration, Philadelphia, Pa.

For primary bibliographic entry see Field 05G.

For abstract, see .

W69-03162

#### DESIGN SENSITIVITY OF POLLUTION CONTROL RESERVOIRS,

Federal Water Pollution Control Administration,

Washington, D. C.

For primary bibliographic entry see Field 05G.

For abstract, see .

W69-03163

## Field 06—WATER RESOURCES PLANNING

### Group 6A—Techniques of Planning

**A PROPOSAL FOR A SYSTEMS ENGINEERING STUDY OF WATER POLLUTION ABATEMENT,**  
Johnson (Bernard) Engineers, Inc., Houston, Tex.  
For primary bibliographic entry see Field 05G.  
For abstract, see .  
W69-03164

**SIMULATION OF REGIONAL ECONOMIC IMPACTS OF WATER RESOURCE DEVELOPMENT,**  
Duke Univ., Durham, N. C. Dept. of Economics.  
For primary bibliographic entry see Field 06B.  
For abstract, see .  
W69-03176

**WHEN IS IT SAFE TO EXTEND A PREDICTION EQUATION--AN ANSWER BASED UPON FACTOR AND DISCRIMINANT FUNCTION ANALYSIS,**  
Pacific Southwest Forest and Range Experiment Station, Berkeley, Calif.  
James R. Wallis.  
Water Resources Res, Vol 3, No 2, pp 375-384, 1967. 10 p, 2 fig, 5 tab, 10 ref.

Descriptors: \*Evaluation, \*Statistical methods, \*Estimating, \*Forecasting, Streamflow forecasting, Floods, Hydrologic aspects.  
Identifiers: Principal components analysis, Linear discriminant functions, Prediction equation relevance.

Prediction equations for hydrologic events developed from one population of observations (watersheds) are often solved for another population that is removed either in time or in space. Predictions of this kind are never certainties, although some predictions are obviously more uncertain than others. This paper proposes an empirical uncertainty classification that may be found useful for separating probably successful from probably unsuccessful extensions of prediction equations. The classification system is illustrated by a prediction equation for suspended sediment discharge developed from some watersheds in California, and by a discriminant function for marine versus non-marine sediments based upon microelements.  
W69-03183

**AN ELECTRICAL RESISTIVITY PROFILE FROM MAHUKONA TO KAWAIHAE, HAWAII,**  
Hawaii State Dept. of Land and Natural Resources, Honolulu. Div. of Water and Land Development; Hawaii Univ., Honolulu. Water Resources Research Center; and Hawaii Inst. of Geophysics, Honolulu.

William M. Adams.

Water Resources Res Center Tech Rep No 23, HIG Ser, HIG-WRCC-1, Nov 1968. 32 p, 11 fig, 5 tab, 6 ref, 2 append.

Descriptors: \*Resistivity, \*Surveys, Groundwater, Hawaii, Electrical studies, Geophysics, Fresh water, Profiles.  
Identifiers: Wenner spread configuration, Insular environments.

An electrical resistivity survey to locate the relatively optimum drilling sites for fresh water exploration was conducted along the Mahukona-Kawaihae Road on the west flank of the Kohala Mountain, Hawaii. A profile of 209 stations was run using the Wenner spread configuration. A procedure, which is probably uniquely applicable to insular environments, was developed for removing the elevation effect from observed apparent resistivity. Because the interpretation of profile data is not absolute, the definite location of fresh-water reservoirs is not determinable directly from these data. However, four relatively optimum sites for additional exploration were determined. (Steinhilber-USGS)  
W69-03184

### 6B. Evaluation Process

**ESTIMATED USE OF WATER IN THE UNITED STATES, 1965,**  
Geological Survey, Washington, D. C.  
C. Richard Murray.  
U S Geol Surv Circular 556, 1968. 53 p, 14 fig, 32 tab, 71 ref.

Descriptors: \*Water utilization, \*Groundwater, \*Surface water, \*Fresh water, \*Saline water, Cooling water, Duty of water, Non-consumptive use, Population, Precipitation (Atmospheric), Reclaimed water, River basins, United States, Water management (Applied), Water reuse, Water supply, Withdrawal, Regions.

Identifiers: Hydroelectric, Off channel, Industrial, Irrigation, Rural domestic and livestock, Thermoelectric, Public supply, Average annual.

A 15% increase in off-channel water use from 1960 to 1965 resulted in an average of 310 billion gallons per day (bgd) being withdrawn for public supply, rural domestic and livestock, irrigation, and industrial uses; that is, 1,600 gallons per capita per day. About 75% of total industrial water was used for cooling purposes in thermoelectric power plants, where fresh water use since 1960 increased about 25% and saline water 33%. Hydroelectric withdrawals, a within-channel nonconsumptive use, increased 15% to 2,300 bgd. Water actually consumed averaged 78 bgd, a 28% increase in 5 years. Groundwater supplied 61 bgd (0.5 bgd saline) and surface water 250 bgd (44 bgd saline) for off-channel use. Reclaimed sewage supplied 2/3 bgd to irrigation and industry. The average annual U. S. streamflow is 1,200 bgd, 4 times the off-channel use and 15 times the consumption. However, the estimated dependable, fresh water supply is only about half the total; and in many river basins, water must be withdrawn repeatedly; and in some basins, more than half the dependable supply is consumed. Water-use data is tabulated by States, water-use regions, and by Water Resources Council regions. (Murray-USGS)  
W69-02840

**THE CALIFORNIA WATER PROJECT: IS PUBLIC DECISION-MAKING BECOMING MORE EFFICIENT,**  
Washington Univ., Seattle.

Gardner Brown, Jr.  
Water Resources Research, Vol. 4, No. 3, 1968, pp 463-469, 27 ref.

Descriptors: Discount rate, Interest rate, Cost-benefit ratio, Economic evaluation, \*Economic efficiency, Non-structural alternatives, Pricing, Investment, Public utilities, \*Water allocation, \*Decision making, \*State governments, Water resource development, Institutional constraints.  
Identifiers: California State Water Project.

It is argued that various published conclusions about the economic performance of the State Water Project are invalid, either because the analysis is internally inconsistent, the scholarship careless, or, although some conclusions are correct, the underlying reasoning is wrong. The argument of superiority of alternative sources of water is discussed, and shown to be in error. Incorrect use of the discount rate, the application of procedures that overestimate net benefits, and the failure to charge a scarcity price for water are inappropriate arguments against the value of the California State Water Project. However, the project can be legitimately criticized from two vantage points: (1) the choice of this particular investment relative to alternative public investment options; (2) lack of efficiency because of the questionable assumptions planners must have made about technological progress and future costs of desalination. As we move from a narrower to a broader frame of reference, the economic virtues of the State Water Project progressively decline. The State's water

pricing policy encourages more efficient resource allocation than that of the Federal Government, but there are plausible grounds for believing that further improvement is possible. (Gargola-Chicago)  
W69-02841

**FIELD LEVEL PLANNING OF WATER RESOURCE SYSTEMS,**  
Harvard Univ., Cambridge, Mass. Harvard Water Program.

Maynard F. Hufschmidt.  
Water Resources Research, Vol. 1, No. 2, 1965, pp 147-165, 27 ref.

Descriptors: \*Water resource planning, \*Decision making, Investment, Project planning, Formulation, Flood damages, Systems analysis, Models, Analytical techniques, Design data, Input-output analysis, \*Optimum development plans, Regional analysis, Linear programming, \*Simulation analysis.  
Identifiers: \*Field level planning.

An examination is made of the process of comprehensive water resource planning from the point of view of how new knowledge can best be brought to bear on the major planning tasks under way. Water resource planning, or water resource system design, is specifically a technique of public investment decision making. An idealized form of the overall planning process consists of four related steps: (1) specifying the objectives of design; (2) translating these objectives into design criteria; (3) using the criteria to formulate specific designs of development and management for water resource systems that fulfill the criteria to the highest degree; and (4) evaluating the consequences of the designs that have been developed. The third step, field level planning, is analyzed from three points of view: (1) underlying theory of field level planning; (2) the process of field level planning; and (3) the techniques of analysis used in field level planning. Major new techniques of analysis, typically computer oriented, include: (1) optimal scheduling methods for the planning task; (2) regional input-output analysis; (3) improved theoretical and practical models of data analysis; (4) linear programming and rough simulation techniques for screening alternatives; and (5) detailed simulation analysis and response surface sampling. (Gargola-Chicago)  
W69-02843

**BROAD HORIZONS IN WATER RESOURCE PLANNING AND INVESTMENT,**  
Resources for the Future, Inc., Washington, D. C.  
Charles W. Howe.  
Water Resources Research, Vol. 2, No. 4, 1966, pp 843-849, 1 tab, 7 ref.

Descriptors: Investment, \*Project planning, \*Non-structural alternatives, Economic efficiency, Interest rate, Financing, \*Water resource management, Water use, Navigable waterways, Cost.  
Identifiers: Private investment, Public sector, Economic interdependence.

Three ways of broadening the horizons in thinking of water resources policy seem worthy of consideration: (1) a geographical broadening that recognizes not merely the physical interdependence in water systems, but the extent of economic interdependence; (2) a sectoral broadening of our perspective that recognizes explicitly the interdependence between the private and public sectors of our economy; and (3) a broadening of the range of policy alternatives that are considered in solving water problems. These points are discussed with emphasis on the broadening of alternatives. It is important to proceed beyond traditional methods of problem solving and institutional arrangements. This should also apply to alternatives that relate to water transportation. It is suggested that rail and barge transportation be coordinated to bring each region acceptable service at minimum cost rather than extending each mode to every region. (Gargola-Chicago)

W69-02845

**THE DYNAMICS OF PUBLIC ROLES IN THE SELECTION OF REVENUE SOURCES IN LOCAL WATER ADMINISTRATION,**

Colorado State Univ., Fort Collins.

Charles L. Garrison, and Duane W. Hill.

Water Resources Research, Vol. 3, No. 4, 1967, pp 949-962, 5 tab, 24 ref.

Descriptors: \*Decision making, Political aspects, Attitudes, \*Behavior, Social values, Sociological aspects, \*Local governments, Methodology, \*Financing, Institutional constraints, Water resource management.

Identifiers: Water resource administration, Public roles.

One of the largest voids in the information available to local decision makers on water use is the knowledge of limits placed upon the policy makers opinions by the respective publics. Results from an effort to classify orientations toward debt-retirement policy alternatives of a special rural-domestic water district's public demonstrated: (1) that persons who would grant flexibility in policy making were lower social status newcomers with a low rate of political participation but a relatively high political efficacy, an urban outlook, high personal rigidity, and high deference toward authority; (2) that the restrictiveness of the resister who comes primarily from the high income, participant-oriented upper middle class is probably a function of his ideological framework and a consistent level of activity that gives him high potential for limiting the policy makers' decision-making options; and (3) that the complaint medium is a viable component for measuring and classifying political behavior. (Gargola-Chicago)

W69-02847

**URBAN AND BASIN PLANNING,**

Wisconsin Dept. of Resource Development, Madison.

Donald F. Wood.

Water Resources Research, Vol. 3, No. 1, 1967, pp 279-283.

Descriptors: \*Urbanization, \*River basin planning, Aesthetics, Water resource planning, Future planning, \*Project planning, Water pollution, Legal aspects, Political aspects, Land use.

Identifiers: Waterfront development.

There are many relationships between urban planning and basin planning. A similarity is that in both areas many of the problems are caused by man's misuse of his land and water resources. Urban renewal programs can be used to enhance the waterfront and destroy sources of pollution that affect entire river basins. Other areas where investigation may indicate relationships are: (1) aesthetics - new interest has been shown in achieving urban beauty and preserving natural beauty; (2) a study of a sociological or political nature which would examine the various groups within the basin and how improvement proposals might affect them; (3) a determination of whether basinwide waterfront land use plans can be drawn and implemented; (4) consideration of the extent to which various alterations to the shoreline or in the streamflow can or should be made; and (5) study of a legal nature which would consider riparian law and whether changes in it are needed. (Gargola-Chicago)

W69-02851

**PROGRAM FOR COOPERATIVE STUDY FOR COMPREHENSIVE WATER RESOURCE DEVELOPMENT,**

New York State Department of Conservation.

Frank J. Keller.

Wa-Ont-Ya Basin Regional Water Resources Planning and Development Board, 1966, 12 pp, 23 append, 3 fig.

Descriptors: \*Formulation, \*River basin development, Administrative decisions, Interagency cooperation, Water resource management, Project planning, State governments, Land use, Financing, Water supply, \*Multipurpose projects, Long term planning, Non-structural alternatives, Programs. Identifiers: Wa-Ont-Ya Basin Regional Water Resource Planning and Development Board, Oswego Basin, New York.

The formation of the Wa-Ont-Ya Basin Regional Water Resources Planning and Development Board has provided the basis for the formulation of a comprehensive plan for development and management of the water and related land resources of the Western Oswego Basin. Future demands of the water resources of the Oswego Basin are expected to increase and other types of uses will develop into major importance. Because of this, the Board believes that comprehensive planning and multiple-purpose development is required if the demands are to be met and resources equitably apportioned. This study is directed toward coordinated multiple-purpose planning and development. The technical scope of the study involves evaluation of all known factors pertinent to the utilization of the water and land resources. A detailed physical description of the basin is given along with a comprehensive outline of the organizational direction of the study. 23 tasks, covering all possible aspects, from water quality to financial feasibility, are discussed and the work outlines for each given. The coordination of activities of all of the agencies participating in the cooperative study is shown through a stated organizational diagram. (Gargola-Chicago)

W69-02854

**OPPORTUNITIES FOR REGIONAL RESEARCH ON WATER RESOURCES PROBLEMS.**

Iowa Univ., Iowa City. Agricultural Law Center.

D. T. Massey, and G. D. Rose.

Opportunities for regional research on water resources problems (Sept 1968) 141 p, 175 ref.

Descriptors: \*Interstate commissions, \*Research + development, \*Water resources development, \*Regional analysis, Geographical regions, Information retrieval, Data storage and retrieval, Inter-basin transfers, Interstate compacts, Long term planning, Multi-purpose projects, Resources allocation, Indirect benefits, Project feasibility, Project planning, Economics, Legal aspects, Regions, Water conservation, Area development.

Identifiers: \*North central region.

This report is a compilation and an analysis of several papers presented at a seminar sponsored jointly by the Water Resources Research Subcommittee, North Central Land Tenure Committee, and the North Central Region Research, Project NC-57, March 26-27, 1968. The purpose of the seminar was to analyze the whole area of regional water research projects, to assess viable opportunities for regional research on water resources in the north central states, to furnish a basis for improvement of regional water research, and to lay a foundation for a long term program of regional research on water. Some of the papers presented analyzed the character and structure of regional research projects, stressing, as a necessary condition, research for the purpose of filling information gaps not indigenous to a single state. Other papers concentrated on the promulgation of new projects and directions for regional water research projects. The impact of water research on other fields was explored and, in particular, the influence on the economic development of areas within the region. A paper was also presented which explained data and information retrieval systems adaptable to water resources. (Sisserson-Fla)

W69-02872

**IVANHOE IRRIGATION DIST V MCCRACKEN.**

For primary bibliographic entry see Field 06E.

For abstract, see .

W69-02896

**NEW TRENDS IN MANAGEMENT OF WATER RESOURCES PROJECTS,**

Bureau of Reclamation, Denver, Colo.

B. P. Bellport.

Eighth Reg Conf Water Resour Develop Econ Comm Asis Far East, Bangkok, Thailand, Nov 1968. 49 p, 26 ref.

Descriptors: \*Water management (Applied), Water resources, Current meters, Agriculture, Irrigation, Operation and maintenance, Irrigation practices, Irrigation efficiency, Water measurement, Water quality, Conveyances, Dam failure, Drainage, Laser, Flow measurement, Foreign countries, Bibliographies, Water utilization, Flowmeters.

Identifiers: Bureau of Reclamation, Economic Commission for Asia, Acoustic method, Dilution method.

New trends in several major aspects of management of water resources developed projects and their significance to ECAFE countries are discussed. Operation and maintenance of water resources projects for irrigated agriculture are emphasized. ECAFE's review of water resources development in the ECAFE region from 1953-1963 stressed opportunities for greater agricultural production through improved managerial techniques. Several elements of management emphasized in the review and their possible impact on water resources development in the ECAFE region are considered. In particular, the paper discusses new trends in use of water on irrigation projects, water measurement, evaluation of quality of water in irrigation development, conveyance of water, and new developments in safety of dams. Also summarized are progress in drainage and several new trends in research influencing management of water resources developments. Although the discussions reflect Bureau of Reclamation progress in operation and maintenance of its water resources projects, the intent of this paper is to highlight those innovations that will be of particular interest and value to ECAFE countries. (USBR)

W69-02944

**THE NATION'S WATER RESOURCES SUMMARY REPORT.**

Water Resources Council, Washington, D. C.

First Nat Assessment Water Resour Counc, Washington, D. C., 1968. 32 p, 21 fig, 2 tab.

Descriptors: \*Water resources, Water Resources Planning Act, Water utilization, Land resources, River basins, Water management (Applied), Watershed management, Consumptive use, Water transfer, International compacts, Drainage basins, Salinity, Sediments, Flood damage, United States, Soil erosion, Bank erosion, Wetlands.

Identifiers: Reports, Federal-state cooperation, Groundwater depletion.

Existing and future water management problems in the 20 geographical regions of the United States are summarized in a rating chart showing relative severity of 10 common problems. These problems include: adequacy of average natural runoff; ground-water storage depletion; water quality (wastes, heat, salinity, and sediment); flood damages; watershed lands; beach, shore, and riverbank erosion; and wetlands. The estimated average annual fresh water supply in each region is compared with current and projected annual withdrawal and consumptive uses. Because of the present and projected inadequacy over the next 50 yr of available water supplies in several regions, alternative means of alleviating such water shortages should be identified and considered. Any study of such alternative means should include: consideration of transfer of water between basins, interstate and international terms and conditions of such possible transfers, protection of areas of origin, economic alternatives available to areas of need, and the national interest of areas of origin and need. (USBR)

W69-02953

## Field 06—WATER RESOURCES PLANNING

### Group 6B—Evaluation Process

#### MODERN MANAGEMENT TECHNIQUES,

Royal Inst. of Public Administration, London (England). Staffordshire Potteries Water Board.

F. L. Ardern, and N. J. Kavanagh.

J Inst Water Eng, Vol 22, No 6, pp 415-465, Aug 1968. 51 p, 5 fig, 7 tab, 10 ref, disc.

**Descriptors:** Management, Decision making, Organizations, Labor, Human behavior, Psychology, Motivation, Reviews, Behavior (Psychology), Labor unions, Wages, Leadership, Environment, Communication, Standards, Work, Mathematical analysis, Analysis, \*Personnel management, Methodology, Benefit-cost ratios, Measurement, Economics, Multiple purpose.

**Identifiers:** Management engineering, \*Water resources management, Managerial skills, Problem solving.

Water resources management can benefit from quantitative techniques developed as management tools and now used in industry. These include work studies and incentives in personnel management, economic-engineering models to aid decisionmaking, and benefit-cost analyses in capital budgeting. Management can improve employees' will to work by proper motivation based on psychological needs; such a system must give management increased productivity and reduced costs and employees more money or satisfaction. Work measurement, incentive bonuses, labor union help to smooth grievances, and team approach to work will yield net financial benefits. To improve his decisions, the manager can use economic-engineering models, treating human and technological variables in the same logical framework. This quantitative model forms a system of equations and inequalities, defining the organization objectives in terms of decisionmaking variables, expressed as a mathematical function. The manager must choose the activity level (given certain constraints) at which costs will be minimum and profits/benefits maximum. Capital budgeting balances the present value against future benefits to assure that future capital goods are worth present consumption sacrifices. (ÜSBR)

W69-02954

#### STATE WATER PLANNING: GOALS AND ANALYTICAL APPROACHES,

Utah Agricultural Experiment Station, Logan.

Delworth B. Gardner.

Utah Agr. Exp. Stat., Utah State Univ. Bulletin 463, Nov 1966, pp 1-38. 39 p, 6 fig, 33 ref.

**Descriptors:** \*Water demand, \*Economic efficiency, Input-output analysis, Recreation demand.

**Identifiers:** Economics, \*Project planning.

The goals and approaches for state water planning and resource development are focused on Utah's policies and problems and to the entire Western United States. Goals in relation to water law, water legislation, and public welfare are discussed. Second, the criteria for determining economic efficiency are given. Efficiency of water allocation is achieved when water is allocated between alternative uses and users in such a way as to maximize the total production of goods and services. The selection of empirical techniques is discussed. The third section discusses the productivity of water in household use, in agriculture, in industry, and in recreation. (Grossman-Rutgers)

W69-02963

#### WATER RESOURCES AND ECONOMIC DEVELOPMENT: THE CHALLENGE TO KNOWLEDGE,

Council of State Governments; and the Southern Land Economic Research Committee.

S. V. Ciriacy-Wantrap.

Water Resources and Economic Development in the South, Agr. Policy Inst., North Carolina State University, August 1965, pp 1-10. 10 p, 12 ref.

**Descriptors:** River basin development, \*Social needs, \*Management, \*Resources.

**Identifiers:** Economics, \*Water policy.

One aspect of water policy is the impact of public investment in water resources on the regional and national economies. The term water policy refers to action of governments at various levels and in various branches affecting the development, allocation, and quality of water resources. In the United States, water is largely developed, allocated, and polluted through decentralized decision making of self-supplying farms, industrial corporations, and non-profit organizations. Therefore, water policy is concerned with the laws, regulations, and administrative structures under which these self-supplying firms make their decisions. Water policy should help to optimize social welfare. (Grossman-Rutgers)

W69-02964

#### CONTROL LEVELS FOR QUANTITATIVE EVALUATION OF WEATHER MODIFICATION ATTAINMENTS,

Colorado State Univ., Fort Collins.

For primary bibliographic entry see Field 02A.

For abstract, see .

W69-03113

#### THE OPPORTUNITY COSTS OF PUBLIC INVESTMENT: COMMENT,

Massachusetts Inst. of Tech., Cambridge.

Peter Diamond.

Quart Jour Econ, Vol LXXXII, No 4, pp 683-688, November 1968, 7 p.

**Descriptors:** \*Taxes, Benefits, \*Consumptive use.

**Identifiers:** \*Social rate of discount, Shadow price, \*Social utility function, \*Public investment, Government production.

In considering rules for public investment to maximize a social welfare function, Marglin has argued for calculations based on a discount rate reflecting the social rate of discount combined with a shadow price of capital. Marglin first presented a simple model and then introduced various complications which did not interfere with its validity. Diamond's approach is the reverse, he starts with a very general model and introduces assumptions which lead to the same conclusion. This approach places in perspective the assumptions leading to the conclusion, for these assumptions appear to the author to be too restrictive to be employed as a basis for policy. The argument is completed with a look at the impact of government taxes and benefits on a consumer with a life-cycle consumption function in a world of perfect foresight. This is shown to create a significant restriction to the assumption that savings depend solely on income, and this, therefore, seems an inappropriate assumption to employ, since the impact of government benefits on private investment is one of the key variables in this problem. (Sokoloff-Rutgers)

W69-03125

#### BENEFIT-COST ANALYSIS AND THE NATIONAL OCEANOGRAPHIC PROGRAM,

Washington Univ., Seattle; Clark Univ., Worcester, Mass.; and Victoria Univ., Toronto (Ontario).

James A. Crutchfield, Robert W. Kates, and W. R. Derrick Sewell.

Natural Resources Journal, Vol 7, No 3, pp 361-375, July 1967. 15 p.

**Descriptors:** \*Cost-benefit analysis, \*Commercial fishing, Benefits, Alternative costs, National income, \*Oceanography, Research and development, \*Sewage disposal, \*Weather forecasting.

**Identifiers:** Mineral production, \*Outdoor recreation, Market prices.

The basic problems of establishing the appropriate level of oceanographic research and its proper allocation among constituent elements of the program will not be resolved by benefit-cost analysis as undertaken in the 1964 National Academy of Sciences study. This area remains one of many in which the economic evaluation of the end products of research and development expenditures cannot yet be done with precision comparable to that

achieved in other types of water development. Yet, the very process of forcing the agencies concerned to isolate and examine the outputs and associated costs resulting from their activities may lead to an internal reordering of programs in the direction of greater efficiency. Some improvement can be realized immediately but only if the benefit-cost criteria are applied correctly and consistently. (Sokoloff-Rutgers)

W69-03126

#### PROBLEMS OF BIAS IN INPUT PRICING FOR BENEFIT COST ANALYSIS: A REPLY,

Federal Reserve System, Washington, D. C.

Robert M. Dunn, Jr.

Southern Econ Jour, Vol XXXIV, No 4, p 571, April 1968. 1 p.

**Descriptors:** Marginal productivity, Marginal income, \*Cost-benefit analysis.

**Identifiers:** \*Input pricing, Producer surplus, \*Consumer surplus, \*Externalities, Factor costs, Alternative uses.

Professor Solo's comment has an unusually broad definition of externalities, which includes both the usual aspects of the term and consumer surplus. Having combined consumer surplus and various 'distant and diffused' externalities in one category, Professor Solo suggests that because it is impossible to allow for all externalities, the exclusion of consumer surplus aspect of costs does not create a bias. The answer to this argument is basically one of symmetry; exclusion does create a bias because the consumer surplus aspect of the benefits is included. Since the costs of a project are the benefits that could have been derived from alternative uses of the resources, there is a theoretical comparability between items on the two sides of a benefit-cost ratio; as a minimum, therefore, the use of benefit-cost analysis would require allowance for costs which are analogous to include benefits. (Sokoloff-Rutgers)

W69-03128

#### THE SOCIAL RATE OF DISCOUNT AND THE OPTIMAL RATE OF INVESTMENT,

Harvard Univ., Cambridge, Mass.

Stephen A. Marglin.

Quart Jour Econ, Vol 77, No 1, pp 95-111, February 1963. 17 p.

**Descriptors:** Consumptive use, \*Investment, \*Growth rates.

**Identifiers:** Saving, Public decisions, Utility function, \*Social welfare function, Income distribution, \*Social rate of discount.

Is the social, collective calculus of saving vs consumption decisions different, or rather should it be different from the individual calculus. Two traditional affirmative answers are evaluated; (1) the authoritarian argument which asserts that individuals do not know what is good for them, and (2) the 'schizophrenia' argument which suggests that an individual acting in collective political capacity is for relevant intents a different person from the same individual acting in the unilateral context of the market. A new argument is then presented which distinguishes the social calculus of investment from the individual calculus on the grounds that only the former allows interdependencies (externalities) to be adequately reflected. Market-determined rates of interest, investment and economic growth need have no normative significance, for they do not reflect the interdependence between one individual's consumption and another's utility. The optimal level of investment is the level at which the marginal productivity of investment equals the marginal social rate of discount incorporating this interdependence. (Sokoloff-Rutgers)

W69-03129

#### PARETO AND THE MARSHALLIAN CONSTANCY ASSUMPTION,

Texas Univ., Austin.

Gerald Higgins, and H. H. Liebhafsky.  
Southern Econ Jour, Vol XXXV, No 2, pp 167-175, October 1968. 9 p.

Descriptors: Demand, Supply, Marginal utility.  
Identifiers: \*Fundamental Equation, \*Income effect, Price elasticity, \*Residual variation, \*Relative price changes, Money income, Numeraire.

This paper attempts to explain and analyze Pareto's interpretation of the Marshallian constant utility of money assumption, as well as to compare Pareto's interpretation with the Hicksian interpretation which seems currently to be the most-widely accepted one. Many analysts have followed Hick's lead and failed to come to grips, in terms of Slutsky's analysis with the assumption they have discussed. It is to be emphasized that Pareto's interpretation of constancy with respect to all prices does not produce an income term equal to zero in the fundamental equation and that clarity requires the analyst to specify the variable with respect to which he supposes the marginal utility of money to be constant. (Sokoloff-Rutgers)  
W69-03130

**EXTERNALITY,**  
Virginia Univ., Charlottesville.  
James M. Buchanan, and Wm. Craig Stubblebine.  
*Economica*, New Series, Vol 29, No 116, pp 371-384, November 1962. 14 p, 2 fig.

Descriptors: Welfare, \*Equilibrium.  
Identifiers: Utility, \*Pareto relevant, Pecuniary, \*Potentially relevant, \*Technological externalities, \*Inframarginal externalities.

Externality is central to the neo-classical critique of market organization. Despite its importance and emphasis, the concept has not been defined rigorously and precisely. This paper attempts such a definition, and interesting implications emerge from the analysis. Specifically, distinctions are made between marginal and inframarginal external effects, between potentially relevant and irrelevant external effects, and between Pareto-relevant and Pareto-irrelevant external effects. The orthodox usage of the term 'externality' is shown to apply only to the Pareto-relevant classification. The analysis demonstrates that external effects may remain even when the necessary conditions for Pareto-optimality are satisfied. Several of the standard propositions stemming from the widely-accepted Pigovian treatment of external effects are shown to be misleading. (Sokoloff-Rutgers)  
W69-03132

**WHAT IS PRODUCER'S SURPLUS,**  
London School of Economics and Political Science (England).  
E. J. Mishan.  
*The American Economic Review*, Vol LVIII, No 5, pp 1269-1282, December 1968. 14 p, 2 fig, 13 ref, append.

Descriptors: Profit, Economic rent, Rent, \*Welfare economics, Supply, Elasticity of supply.  
Identifiers: \*Producer's surplus, Consumer's surplus.

Since Marshall's coining of the term, producer's surplus has been used ambiguously in the literature: sometimes to indicate rent or quasi-rent to a factor, sometimes to indicate profits to an industry. Therefore, this paper suggests that the term producer's surplus be struck from the economist's vocabulary. We already have definitions of profits and rents. No new concept is introduced by producer's surplus. Moreover, the familiar measurement of producer's surplus as the area between the supply curve and the price may be taken as a measure of rent only in cases where one factor is inelastic in supply and all other factors are perfectly elastic in supply and fixed in price. In the common example of an upward-sloping supply curve that is the result of variation in the prices of two or more factors which are inelastic in supply, the area in question does not measure rent to any one or all of the factors and it

does not measure profits to the industry. (Winn-Rutgers)  
W69-03133

#### RECREATIONAL USE OF MUNICIPAL RESERVOIRS,

Cornell Univ., Ithaca, N. Y.; and Michigan State Univ., East Lansing.

Lawrence S. Hamilton, and Emmanuel T. Van Nierop.

Proceedings of the Third Annual American Water Resources Conference (American Water Resources Assn; Urbana, Ill), c 1967, pp 443-455. 13 p, 3 photo, 23 ref.

Descriptors: \*Recreation, Public health, Reservoirs, \*Reservoir management, Water management, Costs, Legal aspects, Administration.  
Identifiers: \*Municipal reservoirs, Entrance fees.

The American Water Works Association now recognizes the inevitability of some degree of recreational use of certain kinds of reservoirs. In deciding whether or not to admit the recreating public to their water supply areas, municipalities should consider cleaning their water fronts and developing new impoundments in which recreation can occupy an exclusive or prominent place. Each situation should be examined independently with regard to the nature and scope of recreation services needed, the intensity of use anticipated, and closeness to urban communities. There are also legal and economic considerations and the authors favor the retention of recreation supervision by the water supply utility. (Winn-Rutgers)  
W69-03136

#### MATHEMATICAL MODELS FOR EXPRESSING THE BIOCHEMICAL OXYGEN DEMAND IN WATER QUALITY STUDIES,

Iowa State Univ., Ames.

For primary bibliographic entry see Field 05G.  
For abstract, see .  
W69-03138

#### LOCAL PARTICIPATION AND WATERSHED DEVELOPMENT: A COMPARATIVE STUDY OF TWO COMMUNITIES,

Mississippi State Univ., State College.

Satadal Dasgupta, and Kenneth P. Wilkinson.

Proceedings of the Third Annual American Water Resources Conference (American Water Resources Assn; Urbana, Ill), c 1967, pp 396-404. 9 p, 1 tab.

Descriptors: Social aspects, \*Social participation, Water resources development, Attitudes, Motivation, Government, State governments.  
Identifiers: Soil Conservation Service, Interactional theory approach.

The main objective of this study was to examine the relationship between participation of local residents and success of watershed development programs. The authors concluded that watershed development projects differ from many other kinds of community projects in (1) the level of technical expertise required for planning and implementation and (2) the degree to which authority for all phases of the project is formally invested in an extra-local agency. Commitment on the part of this agency to involve local citizens and to gear the program to needs felt locally may entail certain risks from a technical standpoint, but may be required from a sociological standpoint if successful implementation of the project is to be assured. (Winn-Rutgers)  
W69-03139

#### CONSUMER RESPONSES TO PRICES OF RESIDENTIAL WATER,

Georgia Univ., Athens.

Ronald M. North.

Proceedings of the Third Annual American Water Resources Conference (American Water

Resources Assn; Urbana, Ill), c 1967, pp 651-663. 13 p, 5 tab, 1 fig, 5 ref.

Descriptors: Water demand, Demand, Water utilization, Water allocation, Water distribution, \*Pricing, Water rates, Elasticity of demand, Income, Prices.

Identifiers: Income elasticity, Price elasticity, \*Consumer response.

Consumers do adjust their domestic water use levels for differences in income levels and for higher or lower prices whenever the variable prices and minimum charges are such that the consumers have a choice of how much water to use. Because of the inelastic demand for water, there is a great opportunity to reduce residential water use through increased prices without reducing total revenue to the utility. Knowledge of the consumer's behavior in the water market should be a useful tool for more accurate water system planning as well as for increased economic efficiency and better distributional effects within each water supply area. (Winn-Rutgers)  
W69-03140

#### THE INCOME REDISTRIBUTION EFFECTS OF RESERVOIR CONSTRUCTION IN APPALACHIA,

Kentucky Univ., Lexington.

L. Douglas James.

Proceedings of the Third Annual American Water Resources Conference (American Water Resources Assn; Urbana, Ill), c 1967, pp 641-50. 10 p, 3 tab, 14 ref.

Descriptors: Value, Income, Reservoirs, Appalachian Mountain Region, Kentucky, Social value, Welfare (Economics), \*Economic efficiency, Benefits, Costs, Flood control, Recreation.  
Identifiers: \*Income redistribution, Dewey Reservoir, Equimarginal sacrifice, Utility analysis.

On the basis of empirical data collected for Dewey Reservoir site construction was found to redistribute income from high to low income groups. Recreation as a project purpose was more effective in achieving this redistribution than flood control. Flood control benefits were found to be relatively greatest for the middle income group. The lower income groups own less damageable real property. The upper income groups pay such a large share of the taxes that the larger share of the flood benefits they realize by owning more property is more than offset. Recreation benefits were relatively greatest for the lowest income group. As income increases, the share of taxes paid increases more rapidly than recreation visitation. (Winn-Rutgers)  
W69-03142

#### PROJECTION OF AGRICULTURAL WATER AND LAND USE FOR LONG RANGE WATER RESOURCES IN TEXAS,

Texas A and M Univ., College Station.

For primary bibliographic entry see Field 03F.  
For abstract, see .  
W69-03144

#### OPTIMIZATION AND RANGE OF APPLICATION OF NUCLEAR REACTORS AND FLASH EVAPORATORS FOR SEA WATER DESALINATION,

Technion-Israel Inst. of Tech., Haifa.

For primary bibliographic entry see Field 03A.  
For abstract, see .  
W69-03147

#### OPTIMAL WASTE TREATMENT AND POLLUTION ABATEMENT BENEFITS ON A CLOSED RIVER SYSTEM,

Toronto Univ., Ontario.

For primary bibliographic entry see Field 05D.  
For abstract, see .  
W69-03150

## Field 06—WATER RESOURCES PLANNING

### Group 6B—Evaluation Process

#### COMPUTER SIMULATION MODELS FOR RIVER-BASIN ANALYSIS AND PLANNING,

Battelle Memorial Inst., Columbus, Ohio.

Henry R. Hamilton.

Battelle Memorial Institute Reprint, 1968. 18 p, 3 fig, 1 tab, 3 ref.

Descriptors: \*Simulation analysis, River basins, Computer models, \*Decision making, \*River basin development, Planning, \*Regional analysis, Human population, Economic prediction, Water policy, Water resources development, Water quality, Water demand, Systems analysis, Recreation, Employment, Dissolved oxygen.

Identifiers: \*Susquehanna River Basin, \*Feedback relationship, Demographic sector, Critical point concept.

A simulation model of the Susquehanna River Basin was constructed and the results and conclusions from the study were discussed in order to show the advantages of a simulation approach to complex system modelling with feedback characteristics. The model was comprised of three major sectors, the demographic (or population change) sector, the economic activity sector and the water sector. The sectors were interlinked, with changes in economic activity affecting population migration, and both affecting water quality and quantity, which could in turn affect economic activity. These feedback relationships were discussed and diagrammed. The water sector specified the water demand, quality (DO), pollutant discharge amounts, and flow levels at critical points. Results of the Susquehanna study were shown. It was concluded that simulation models should be flexible in order to study policy alternatives, and redirect efforts in discovered critical areas. (Gysi-Cornell)

W69-03153

#### OPTIMIZATION BY DYNAMIC PROGRAMMING OF HYDROELECTRIC PLANT OPERATION REGIME DURING INITIAL FILLING PERIOD OF MULTIANNUAL REGULATION RESERVOIR,

For primary bibliographic entry see Field 06A.

For abstract, see .

W69-03155

#### THE INTERINDUSTRY WATER CONTENT MATRIX: APPLICATIONS ON A MULTIREGIONAL BASIS,

California Univ., Berkeley.

For primary bibliographic entry see Field 06A.

For abstract, see .

W69-03157

#### WATER QUALITY ANALYSIS OF THE DELAWARE RIVER ESTUARY,

Manhattan Coll., Bronx, N. Y.; and Hydroscience, Inc., Leonia, N. J.

For primary bibliographic entry see Field 06A.

For abstract, see .

W69-03158

#### DESIGN OF OPTIMAL WATER DISTRIBUTION SYSTEMS,

Technion - Israel Inst. of Tech., Haifa.

David Karmeli, Y. Gadish, and S. Meyers.

Proc Amer Soc Civil Eng, Vol 94, No PL1, pp 1-10, Oct 1968. 10 p, 2 fig, 3 tab, 2 ref, 2 append.

Descriptors: \*Water distribution (Applied), \*Linear programming, \*Optimization, Hydraulic gradient, Network design, Pressure, Digital computers.

A linear programming solution was presented for the problem of selecting optimal pipe diameters and heads for a water distribution network. The water discharge and pressure requirements at all points in the system were assumed to be known and constant, and the network configuration was assumed given. The objective was to find the minimum capital and annual costs for the system. A numerical example was presented. The method was

only suitable for branched networks (i.e. systems without loops). The problem was solved by use of a digital computer. (Gysi-Cornell)

W69-03165

#### RESEARCH ON COMPREHENSIVE PLANNING OF WATER-RESOURCE SYSTEMS SYMPOSIUM,

North Carolina Univ., Chapel Hill.

Maynard M. Hufschmidt.

Natural Resources Journal, Vol 5, No 2, pp 223-235, October 1965. 13 p.

Descriptors: Federal project policy, \*Water resources development, Research and development, \*Design criteria, Alternative costs, Regional analysis, Economic prediction, Analytical techniques, Optimization.

Identifiers: \*Harvard Water Program, Comprehensive planning, Design objectives.

Water resource research is classified according to one of the processes used by man to control and adapt water resources: comprehensive water resource planning or water-resource system design. The paper discusses research needed and research in water-resource system design in progress at Harvard. Research needs are related to three steps of the planning process: establishing the objectives of design; translating objectives into design criteria; and designing the system. Problems in establishing objectives of design include the development of workable criteria by government and the competing objectives of different levels of government. Topics discussed under translating objectives into design criteria include standards and criteria of the political process, the role of benefits in plan formulation, definition of the planning region and the scope of planning. The system design includes the full range of studies and analyses involved in regional plan preparation: techniques for regional economic projections; derivation of water-resource benefit functions; deriving the technological function; preliminary screening techniques for system design; techniques for studies leading to optimization; and the process as a whole, e.g., selection of test areas and evaluation of case studies. (Abodeely-Chicago)

W69-03166

#### SOME PHYSICAL, TECHNOLOGICAL, AND ECONOMIC CHARACTERISTICS OF WATER AND WATER RESOURCE SYSTEMS: IMPLICATIONS FOR ADMINISTRATION,

New Mexico Univ., Albuquerque. Dept. of Civil Engineering.

Blair T. Bower.

Natural Resources Journal, Vol. 3, No. 2, pp 215-238, October, 1963, 24 p, 6 fig.

Descriptors: \*Administrative agencies, Non-structural alternatives, Input-output analysis, Economics of scale, Surface water, Ground water, Water quality, \*Water resources development, Areal profiles, Water supply, Water demand, Reservoirs. Identifiers: \*Water resources system, Alternative plans.

In the future water resources administration will be more concerned with the use of developed supplies than the development of new supplies. Water resources administration is defined as a collectivity of functions which may be grouped as follows: making the investment decision; constructing structural facilities and organizing nonstructural measures and operating the system. A water resource system is defined as a configuration of structural and non-structural measures and procedures which transforms water into outputs of products and services. The physical nature of the inputs and outputs of the production process, and the technology available, set limits on the organizational structure for water resource administration. The study of water resource systems suggest an administrative agency with the following characteristics: is unitary; has jurisdiction over the quantity and quality of surface and ground water; is re-

gional; is flexible over time with respect to areal jurisdiction and outputs provided; is integrated and large enough for economies of scale; has responsibility for the range of outputs; is required to consider a range of alternatives; and is responsible for planning, design, and operation. (Abodeely-Chicago)

W69-03167

#### WATER RESOURCE MANAGEMENT IN MT. PROSPECT: A SURVEY OF THE ENVIRONMENT, PROBLEMS, AND OPPORTUNITIES,

Sheaffer (John R.) and Associates, Wheaton, Ill.

John R. Sheaffer, Emil Oelberg, and James E.

Hackett.

Wheaton, Ill., December 1968, 30 p, 9 fig, 1 tab, 2 ref.

Descriptors: Flood plain zoning, Detention reservoirs, Multiple-purpose reservoirs, Consumptive use, Flood forecasting, Non-structural alternatives, \*Regional analysis, Administrative agency, Aquifers, \*Urbanization.

Identifiers: Mt. Prospect (Ill), Northeastern Illinois region.

A series of chronic water problems which included sewer back-up, flooding, pollution in the channels and falling water levels in the municipal wells reached serious proportions in a heavy storm in June 1967. A Drainage and Clean Streams Commission was organized to correct the problems and to examine the water resource opportunities available to Mt. Prospect. An analysis of the physical setting reveals a tendency to avoid using the shallow aquifer with the resultant underdevelopment of the ground water source in the region. Urbanization has altered to a large degree the physical environment in the Mt. Prospect area. The most significant effects of urbanization has been caused by the sewerage and drainage system and development in flood prone areas. The study proposes a comprehensive program of water resource management based upon structural and non-structural alternatives and compatible with programs of ongoing municipalities and regional agencies. Recommendations include: (1) flood plain management; (2) water use management; (3) flood water storage; (4) construction of a multi-purpose lake as detention reservoirs and recreational and esthetic purposes; and (5) an increase in the flow potential of Weller Creek, on of Mt. Prospects' natural drainage outlets. (Starr-Chicago)

W69-03168

#### ROOKERY BAY AREA PROJECT: A DEMONSTRATION STUDY IN CONSERVATION AND DEVELOPMENT, NAPLES, FLORIDA.

Conservation Foundation, Washington, D. C.

Washington: Conservation Foundation, 1968, 61 p, 11 photo, 4 tab, 5 illus.

Descriptors: \*Land use, Topography, Administrative agency, Channels, Water pollution control, Recreation demand, Fish management, \*Multiple-purpose projects, Water resources development, \*Project planning.

Identifiers: Centralization, Ecological balance, Naples (Florida), Rookery Bay (Florida).

Development pressures in the area between Naples and Marco Island, Florida are increasing enough to warrant concern over the possibility of losing some of the area's natural values and damaging the quality of the environment. Achieving the dual objectives of profitable development and protection of the natural resources will require coordination of both the public and private sectors. Five recommendations are made: (1) Creation of a single coordinating development mechanism; (2) Development of a plan that will include a water pollution control program and a system of navigable waterways; (3) Development of a land use plan that will provide for a variety of uses; (4) Innovation in planning and design techniques to include such practices as cluster and open space commun-

**Evaluation Process – Group 6B**

ty development; and, (5) Setting aside appropriate areas for recreational and resort use that would utilize the area's natural resources and topography. (Starr-Chicago)  
W69-03169

**WATER RESOURCES MANAGEMENT IN MARYLAND.**

Maryland Dept. of Water Resources, Annapolis.

Maryland Univ: Water Resources Study Committee, August, 1967, 87 p, 7 fig, 3 tab, 75 ref, 4 append.

Descriptors: \*Administrative agencies, Flood plain, Pollution abatement, Reservoir sites, \*Water resources development, Water quality, Information retrieval, Education, Water rights, Legal aspects, Maryland.

Identifiers: Environmental quality.

The report is concerned with clarifying the role and identifying the responsibilities of the newly designated Maryland Water Resources Department. Recommendations of the report include a statement of state policy and a plan for water resource development, a computerized data system, pollution control and regulation of flood plains and reservoir sites, regulations of non-domestic water use, the establishment of specific posts and facilities, and the execution of various other suggestions for educational programs procedures, and internal staffing. The role of the State—present and future—is presented as a philosophy of state control of the development and management of water resources. Excellence in water resources management is cited as the key to environmental quality in the State. Problems of growth and program management and some opportunities in public awareness and scientific and governmental capabilities are identified. Water rights developed through court decisions as part of Common Law and some of their limitations are reviewed. Responsibilities of a State Department of Water Resources are outlined and discussed. (Abodeely-Chicago)

W69-03170

**MARYLAND'S ROLE IN WATER RESOURCES DEVELOPMENT.**

Maryland Univ., College Park. Water Resources Study Committee.

Maryland Univ: Water Resources Study Committee, February 1967, 85 p, 1 fig, 26 ref, 2 append.

Descriptors: State jurisdiction, Administrative agencies, \*Population growth rates, \*Water demand, Withdrawal, Reservoirs, Dams, \*Water resource development, Interstate compacts, Research and development, Potential aspects, Federal budgets, Sewerage facilities, Maryland. Identifiers: METRO MARYLAND, Interstate waters.

The emerging water problems in Maryland can be understood in terms of two factors: the need for government involvement in water resources and changing patterns of relations among various levels of government in local development. The water situation in Maryland is assessed in light of problems relevant to new or redirected programs. The main problem of water in relation to development is one of population concentrations rather than absolute shortage. Metro-Maryland and three non-metropolitan regions — Southern Maryland, Eastern Shore, and Western Maryland — are identified and characterized with respect to water problems. Three general types of responsibility in water use and development are suggested: (1) to prosecute Maryland's interest in interstate waters; (2) to assure optimal use and development of natural waters under its jurisdiction; (3) to assure efficiency in the provision of water and sewerage service in the overlapping metropolitan areas. Ten 'next steps' suggested to fulfill the three responsibilities are documented. (Abodeely-Chicago)

W69-03171

**WATER RESOURCES: A REPORT TO THE COMMITTEE ON NATURAL RESOURCES OF THE NATIONAL ACADEMY OF SCIENCES - NATIONAL RESEARCH COUNCIL,**  
National Academy of Sciences-National Research Council, Wash., D. C., Committee on Natural Resources.

Abel Wolman.

Washington: National Academy of Sciences - National Research Council Pub. 1000-B, 1962, 35 pp, 1 fig, 1 tab.

Descriptors: \*Research and development, Use, Water allocation, Water supply, Water demand, Withdrawal, Data, Storage and retrieval, Evapotranspiration, Humid areas, Semi-arid climates.

Identifiers: Interdisciplinary training.

The purpose of the report is to identify some significant problems in the water resource field and indicate some areas of scientific research needed as a basis for better planning and policy formulation. The hydrologic cycle is described and some aspects of water resource requirements in the United States are discussed. Research needs in the area of resource management and water resource development are identified. Suggested areas of research are cited as those directed to problems of improved and more productive water-resource development and use in arid and semi-arid basins, in humid basins, and all areas, and longer range and more specific research areas with potentially large payoffs. Examples of recommended research are presented for each category. Areas for multidisciplinary investigation, with suggested priorities, are outlined. Summary conclusions list the following areas of research for urgent consideration: interdisciplinary training of personnel; research relevant to ground water supplies; research in systems for development of water resources; research with regard to evaporation suppression and transpiration control; and research aimed at developing water-purification methods and forecasting the effects of pollution damage. (Abodeely-Chicago)

W69-03172

**WATER RESOURCES STUDY, COMPREHENSIVE PLANNING PROGRAM, JEFFERSON COUNTY.**

Jefferson County Regional Planning Commission, Steubenville, Ohio.

Steubenville, Ohio, September 1968, 47 p, 2 fig, 13 tab, 2 append.

Descriptors: Ohio River, Industrial wastes, Land development, Flood control, \*Water demand, Water quality, \*Water resources development, Water pollution, Organic wastes, Sewage treatment.

Identifiers: Jefferson County (Ohio), Water quality criteria.

The Ohio River provides the major mode of transportation of raw materials and products to and from the region, and it is still the only source of water for the two largest cities in the county. Industrial, residential, and commercial development along the river has been related to the water resource. A combination of factors has created conditions of blight along the waterfront which should be addressed. Sources of water available to Jefferson County are discussed: the Ohio River, its tributaries, and alluvial deposits. Demand in the three-county region is based mainly on domestic, commercial and public use. Other uses are for recreation, waterborne commerce, and waste disposal. Water pollution control is handled by several governmental jurisdictions from a state to a federal level. Flood control structures along the Ohio River protect against all but major floods of rare occurrence. An inventory of surface and ground waters in Jefferson County is presented in text and tables. Factors affecting surface and ground water quality in the county are cited, and water quality in the county is appraised. A final section relates water resources to land development. (Abodeely-Chicago)

W69-03174

**SIMULATION OF REGIONAL ECONOMIC IMPACTS OF WATER RESOURCE DEVELOPMENT,**  
Duke Univ., Durham, N. C. Dept. of Economics. John C. Meadows, and Thomas H. Naylor, Report No. 16, Water Resources Research Institute of the University of North Carolina, Jan 1969. 16 p, 2 fig, 34 ref. OWRR Project A-024-NC.

Descriptors: \*Economic impact, Input-output analysis, \*Simulation analysis, \*Water resources development, Water yield.

Identifiers: Economic base studies, Dynamic computer simulation models.

This report summarizes the results of a project concerned with evaluating the impact of water and timber availability on regional economic development in the Southeast. Several alternative techniques are considered for accomplishing this objective including input-output models, economic base studies, and dynamic computer simulation models. These techniques are compared and critically evaluated in the light of the goals of this study. The impact of water availability on regional economic growth in the Southeast was found to be indirect, and it was demonstrated that water is such a small fraction of total industrial production costs that it is unlikely to be critical in plant location decisions. The authors recommended that policymakers should consider more carefully the trade-offs between land use for timber production and land use for water production.  
W69-03176

**ARKANSAS WATER RESOURCES: SUPPLY, USE, AND RESEARCH NEEDS,**  
Arkansas Univ., Fayetteville. Dept. of Economics. Jared Sparks.

Arkansas Water Resources Research Center, Research Project Technical Completion Report, December 1966. 100 p, 10 tab, 15 fig. OWRR Project A-006-Ark.

Descriptors: \*Research and development, Multiple purpose reservoirs, \*Water supplies, Chemicals, Sediments, \*Water pollution, Flood, \*Surface water, \*Ground water, \*Water utilization, Water balance, \*Economics, \*Water management, \*Hydrologic data, Groundwater recharge, Limnology.

The purpose of this study is to identify Arkansas' water resources research needs against an economic backdrop of water supply and use conditions existing in the state. In the aggregate Arkansas has an abundance of high quality water relative to present use. There are local conditions that give rise to water problems, but, in general, critical water problems in Arkansas are emergent and potential rather than actual. The causes of these problems are to be found, in large part, in the economic, legal, and social institutions surrounding water use—and particularly in the economic institutions. Research designed to improve economic efficiency criteria and to develop methods of applying such criteria to water resources planning, to water resources allocation, and to quality of water control would do much to mitigate the problems of water management in the future. Research of this nature requires considerably more water data concerning supply, use, and costs associated with water use than are now available. Other promising areas of research include basic research on the nature of water and the water cycle, and applied research in areas of flood control, artificial recharge, the measurement of pollution damage and costs, the identification and treatment of pollution, the limnology of artificial lakes, and the role of water resources in industry location.  
W69-03199

## Field 06—WATER RESOURCES PLANNING

### Group 6C—Cost Allocation, Cost Sharing, Pricing/Repayment

#### 6C. Cost Allocation, Cost Sharing, Pricing/Repayment

##### APPROPRIATIONS FOR CONSTRUCTION OF WATER AND SEWER LINES.

N.C. Gen Stat sec 153-11.2 (1964).

Descriptors: \*North Carolina, \*Legislation, Cities, Taxes, \*Conduits, Pipes, Sewerage, Sewers, \*Public health, Mills, Industries, Industrial plants, Legal aspects.

The board of county commissioners in any county in North Carolina is authorized and empowered to appropriate, make available, and spend, from any surplus funds or any funds not derived from tax sources which are available to the board, or amount which, in the discretion of the board, is to be used for the purpose of building water and sewer lines from the corporate limits of any municipality in the county to communities or locations outside the city. These water lines shall be built and constructed for the general public health for promotion of public health in communities and locations in the State where large groups of employees live in and around factories and mills, and for industrial development. (Watson-Fla)  
W69-02894

##### THE ECONOMIST'S ROLE IN WATER PRICING POLICY,

California Univ., Davis.

W. E. Johnston.

Proc Water Pricing Policy Conf, Univ California, Los Angeles, pp 28-41, Mar 1968. 14 p, 5 fig, 8 ref.

Descriptors: \*Economics, \*Water costs, \*Policy matters, Prices, Water, Water resources development, \*Pricing, Cost-benefit analysis, Indirect benefits, Water resources, Water utilization, Direct benefits, Economic feasibility, Water demand, Economic justification, Benefit-cost ratios.  
Identifiers: Allocations, Price system theory.

The economist has taken a minor role in the development of water resources. He is well qualified to be a full participant along with the engineer, lawyer, auditor, political scientist, and water user, but his role has been that of a critic after the fact rather than a strong voice in actually determining water pricing policies. Economic feasibility and benefit-cost studies have called for the economist to evaluate previously selected projects for their economic merit. Few calls have been extended for economists to aid in selecting projects to meet a desired development objective. Reasons why economists have been excluded (or have excluded themselves) from exerting a strong voice in water resource development and use are discussed. Other subjects reviewed include: (1) price as an allocator, (2) cost responsive pricing, (3) water as a heterogeneous commodity, (4) short-run elasticities and long-run investments, (5) political economy, and (6) price structures of retailing agencies. (USBR)  
W69-02906

##### A CONTRIBUTION TO THE THEORY OF THERMO-ECONOMICS,

California Univ., Los Angeles.

Robert Evans.

Water Resources Center contribution No 56, Department of Engineering, University of California, Los Angeles, August 1962. 125 p, 10 fig, 3 tab, 5 append, 26 ref.

Descriptors: Environment, Entropy, Diffusion, Sea water, \*Enthalpy, Free energy.

Identifiers: Production region, \*Energy cost, Steady state, Design of production plants, \*Available energy function, \*Thermodynamics.

A rigorous derivation is given for a new thermodynamic property herein called the 'available-energy function'. This function represents a

generalization of Keenan's availability concept. However, the available-energy-function proposed is free from certain restrictions which limit the use of Keenan's availability function in thermo-economics (this term signifies the simultaneous application of thermodynamics and economics). This concept is shown to provide a unified approach to all energy cost problems. For example, it is the available-energy content of a fuel, not its energy content, which is of economic importance. Any energy cost equation takes on its simplest form when it is expressed in terms of available-energy costs. A general equation for the minimum cost of fresh-water from the sea is then given in terms of available-energy costs. The general equation was applied to specific cases in which it gave essentially the same results that have been reported by others for vapor-compression distillation, multi-stage flash-distillation, and electro-dialysis. (Sokoloff-Rutgers)  
W69-03131

##### WATER SHORTAGES AND PRICING,

Cornell Univ., Ithaca, N. Y.

Louis Michael Falkson.

Proceedings of the Third Annual American Water Resources Conference (American Water Resources Association; Urbana, Ill), c 1967, pp 254-260. 7 p, 3 fig, 7 ref.

Descriptors: \*Water allocation, \*Pricing, Water shortage, Water demand, Marginal cost, Welfare (Economics), Marginal benefits, Water rates.  
Identifiers: Utility analysis.

Many public water supply systems levy a flat rate service charge rather than billing their customers on the basis of the quantity of water which they consume. The loss in welfare from this practice results from the fact that the marginal value in use might not be equal for all consumers if the water system is not able to supply the entire market demand at a zero price. Various methods should be considered to increase the probability that the more urgent demands for water are satisfied. The enforcement of any rationing scheme involves some cost. A pricing mechanism is often the least expensive rationing device to insure that scarce resources are allocated to uses with the greatest value. (Winn-Rutgers)  
W69-03135

##### DESIGN OF OPTIMAL WATER DISTRIBUTION SYSTEMS,

Technion - Israel Inst. of Tech., Haifa.

For primary bibliographic entry see Field 06B.

For abstract, see .

W69-03165

##### A STUDY IN THE ECONOMICS OF WATER QUALITY MANAGEMENT,

Federal Water Pollution Control Administration, Washington, D. C.

For primary bibliographic entry see Field 05G.

For abstract, see .

W69-03173

#### 6D. Water Demand

##### ESTIMATED USE OF WATER IN THE UNITED STATES, 1965,

Geological Survey, Washington, D. C.

For primary bibliographic entry see Field 06B.

For abstract, see .

W69-02840

##### POPULATION GROWTH AND THE DEMAND FOR WATER,

Council of State Governments; and Southern Land Economic Research Committee.

Clarence M. Conway.

Water Resources and Economic Development in the South, Agr. Policy Inst., North Carolina State University, Aug 1965, pp 11-16, 6 p.

Descriptors: \*Forecasting, Population, Water policy.  
Identifiers: Economics, \*Water demand.

By the year 2000 the population in the South will probably have doubled. This increase in population will not put impossible demands on the water resources of the area, except for some urban areas where population is concentrated. Water pollution is depleting our usable supplies of water. By 2000 the daily per capita demand for water is projected to be 200 to 225 gallons. Use of water for municipal, industrial, pollution abatement, navigation, wildlife preservation, and recreation purposes are also expected to increase greatly by the year 2000. The problem with which we are confronted is the efficient use of the water available. New water supplies must be opened, the use of ground water without mining must be expanded, water must be reused as many times as possible, and the polluted lakes and streams must be cleaned up. There are needs for equitable water rights legislation, enforceable water quality controls, and education of the public in the conservation and uses of water. (Grossman-Rutgers)  
W69-02962

#### 6E. Water Law and Institutions

##### POLITICS AND ORGANIZATION IN WATER RESOURCE ADMINISTRATION: A COMPARATIVE STUDY OF DECISIONS,

Syracuse Univ., N. Y.

Frank Munger, and Ann Houghton.

Water Resources Research, Vol. 1, No. 3, pp 337-47, Third Quarter 1965. 11 p, 1 tab, 11 ref.

Descriptors: \*Decision making, \*Administrative agencies, Administrative decisions, Water resource management, Local governments, State governments, Federal governments, Hydroelectric power, Single purpose projects, Political aspects, Public benefits, Flood control.

Identifiers: Private development, Corps of Engineers, Bureau of Reclamation.

The paper is concerned with the relationship between political forces and the choice between private and public administration of control of surface water flows. Using data from the USGS, patterns of control of usable storage are analyzed in 16 major river valleys and a sample of 145 reservoirs is employed to analyze the distinctions between public and private development; among the local, state, and federal levels of government, and among the particular federal development agencies involved. The study indicates that private development is associated with hydroelectric power generation and single purpose development and is favored in eastern states, and public development is replacing private development. The level of government involved is related to political context and functional purposes, with local government most active in water supply, special districts with reimbursable functions, state agencies with non-reimbursable functions, federal government with nonreimbursable functions and federal government with flood control projects. The Corps of Engineers is the main federal development agency with the Bureau of Reclamation operating only in reclamation states. (Abodeely-Chicago)  
W69-02849

##### THE MUSKINGUM WATERSHED CONSERVANCY DISTRICT: A STUDY OF LOCAL CONTROL,

Lyle E. Craine.

Law and Contemporary Problems, Vol. 22, No. 3, 1957, pp 378-404, 16 ref, 1 map.

Descriptors: \*Local governments, State governments, Water resource management, Flood control, Legislation, Legal aspects, Financing, Land use, Drainage districts, \*River basin development, Institutional constraints, Interagency cooperation, Decision making.

**Identifiers:** Conservancy Act, Muskingum Watershed Conservancy District.

The study and appraisal of various efforts in drainage basin development are fundamental to a better understanding of the requirements for effective administration of water resources effort. The Muskingum Watershed Conservancy District (MWCD) is unique in the fact that it was one of the first instances of cooperation between the United States government and a local subdivision of a state government in such work. Certain facets of MWCD's experience are explored, in an attempt to evaluate that agency's success in planning and carrying out a land and water development program. Four problems are discussed: (1) How effective has the MWCD been in developing and maintaining a comprehensive program of land and water development in the Muskingum basin; (2) How effective has the MWCD been in maintaining local direction and control of the development program; (3) What are the forces which have played upon the MWCD in its effort to maintain a comprehensive program and to retain local direction and control of the basin's development; and (4) What does the MWCD's success and failures suggest as to the role of a small agency for drainage basin development. A description and history of the conservancy district organization is given; originally, it was aimed only at flood control. (Gargola-Chicago)  
W69-02852

#### ROLE OF LOCAL GOVERNMENT IN WATER LAW, Andre Saltoun.

Wisconsin Law Review, Jan. 1959, 25 pp.

**Descriptors:** \*Legal aspects, \*Local governments, Navigable waterways, Well permits, Riparian rights, Zoning, Regulation, Public utility, Water law, Municipal water supply, Water quality control, Distribution, Legislation, Jurisdiction, State governments.

**Identifiers:** Wisconsin law.

The extent to which local government plays a part in shaping private and public rights to use water in Wisconsin is examined. It is the opinion of the author that no study of water law is complete which does not consider the impact and effect of local governments. In an attempt to explore this problem, various roles of local governments are discussed. The local government as a public utility and its means of regulation are considered. Municipal regulation of water use by sprinkling ordinance, private well permits, restrictive service and compulsory connections are presented and the legal ramifications of these actions are explored. The second discussion concerns the role of local governments in the administration of the public trust in navigable waters. The source of the 'trust doctrine' and the legal aspects of the power, authority, and regulations that accompany it are outlined. The third role is that of riparian zoning. This is the principal factor that affects water rights. By zoning riparian land, local governments can regulate the use of water, thereby limiting riparian rights. Discussed are: (1) zoning and conflicting group interests, (2) constitutional issues, (3) public vs. private interest, and (4) relevant court decisions. (Gargola-Chicago)  
W69-02853

#### EMINENT DOMAIN - PONDS, DAMS, RESERVOIRS - PUBLIC UTILITIES.

NC Gen Stat sec 62-183 (1946).

**Descriptors:** \*North Carolina, \*Legislation, \*Eminent domain, Mills, Electric powerplants, Right-of-way, Condemnation, Easements, Pipes, Powerplants, Reservoirs, Dams, Ponds, Diversion, Ditches, Conduits, Channels, Flumes, \*Hydroelectric plants, Obstruction to flow, Legal aspects, Compensation.

Telegraph, telephone, electric power or lighting companies are entitled, upon making just compensation to the owner, to take such lands as may be necessary for the establishment of their reservoirs, ponds, and dams. Such companies also have the right to divert the water from such ponds or reservoirs and to conduct it, in any manner, to the point of use for the generation of power. This water must be returned to its proper channel after use. However, if the above mentioned activities interfere with any mill, power plant, or other water power facility already in operation, a court order approving the condemnation must be secured. The court order will be issued only when: (1) the electric power company is unable to agree with the owners for the purchase, and (2) the taking of such mill or water power will be greatly more to the benefit of the public than the continued present use. (Watson-Fla)  
W69-02857

#### STATE V LANZA (EMINENT DOMAIN). 48 NJ Super 362, 137 A 2d 622-632 (1957).

**Descriptors:** Judicial decisions, Legal aspects, \*New Jersey, \*Eminent domain, \*Water supply, Water policy, Condemnation, Legislation, Water resources development, State governments, Administrative agencies.

The State of New Jersey sought to condemn certain lands of the plaintiff for future establishment of a water supply system pursuant to a legislative enactment. The act authorized the Commissioner of Conservation and Economic Development to acquire 'such part of the area... which in the judgment of the Commissioner is appropriate and useful.' The Constitution places limitations on the legislative power of eminent domain. The act authorizing the Commissioner to use his judgement in selecting certain lands for the future establishment of a water supply system was not an unconstitutional delegation of power. The act was sufficiently definite to serve as a constitutionally adequate guide for the Commissioner. (Molica-Fla)  
W69-02860

#### HAMMETT V ROSENHOHN (ACTION TO DETERMINE EFFECT OF RESTRICTIONS IN DEED). 46 NJ Super 527, 135 A 2d 6-14 (App Div NJ 1957).

**Descriptors:** \*New Jersey, Judicial decisions, \*Scenic easements, Legal aspects, \*Lake shores, Land use, Ponds, Beaches, Easements, Relative rights, \*Recreation, Contracts.  
**Identifiers:** Deeds, Restrictive covenants.

Plaintiff conveyed a portion of his land to a corporation. The parties agreed to protect their respective properties and to maintain them as country estates, with a country home and wide view of the countryside, together with a pond for recreation. They agreed to restrict the use of their properties and to establish easements (these easements being specifically set out in the deed). Defendant later acquired title to the corporation's parcel of land by deed which recited that the conveyance was subject to the earlier restrictions and agreements. Defendant wished to change the existing shore line of the pond, create a beach, and build a boathouse which was to have other recreational facilities. All these undertakings were in violation of the said agreements. In an action to determine the respective rights of the parties and the effect of the earlier agreements, the lower court upheld the restrictions. The Court ruled that they were definite, reasonable, not against public policy, capable of enforcement, and had not been waived by the plaintiff. The Court disregarded Defendant's argument that the agreements were personal between the parties to the earlier deed. The Supreme Court of New Jersey affirmed. (Wheeler-Fla)  
W69-02861

#### CUGLAR V POWER AUTHORITY (EMINENT DOMAIN BY POWER AUTHORITY TO FORM POWER POOL).

4 A D 2d 801, 164 N Y S 2d 686-688 (Sup Ct 1957).

**Descriptors:** \*New York, Judicial decisions, \*Eminent domain, \*Administrative agencies, Administrative decisions, Condemnation, Islands, Dams, Reservoirs, \*Hydroelectric power, Legal aspects.

Plaintiffs sought to enjoin the Power Authority of the State of New York from initiating eminent domain proceedings against the land. This land would be transformed into an island after a proposed power pool was formed. Plaintiffs alleged that such a taking was not essential to public use in that the Power Authority intended to redevelop the property for residences, parks, and other community uses. The complaint included brochures published by the Power Authority stating this intention. On appeal from a judgment dismissing the complaint, the Supreme Court, Appellate Division, affirmed. The court recognized that even if the lands in question were leased to others, it would remain within the ownership and control of the Power Authority. It held that it was necessary for the Authority to control the land in question. The facts of the case are fully set forth in the lower court opinion, 163 N Y S 2d 902 (Sup Ct 1957) (Abstract No 1821). (Williams-Fla)  
W69-02863

#### CONNECTICUT WATER LAW: JUDICIAL ALLOCATION OF WATER RESOURCES. Connecticut Univ., Storrs. Inst. of Water Resources.

Connecticut Water Law: Judicial Allocation of Water Resources (1967), 215 pp, 557 ref.

**Descriptors:** \*Connecticut, Water law, Judicial decisions, Riparian rights, Water pollution, Surface waters, Ponds, Reasonable use, Diversions, Municipal water, Relative rights, Navigable waters, Non-navigable water, Riparian waters, Navigation, Channeling, Recreation, Access routes, Cities, Improvements, Dams, Legal aspects, Public rights, Riparian land, Ground water, Usufructuary right.

This study was initiated by necessity; arising because of the absence of any recent work devoted to Connecticut Water law and the specific need that such a work be compiled by an interdisciplinary study of water resource allocation. The author studied more than two hundred court decisions in preparing the work. This method aids in the development of rules of use and ownership, and it isolates the most recurring forms of conflict within the state. Reis recognized four distinct categories of water which the courts have developed: (1) surface waters flowing in a definite channel - public; (2) surface waters flowing in a definite channel - private; (3) ground water; and, (4) diffuse surface waters. The study is divided into four parts. The first, and most extensive, is entitled 'Riparian Rights in Nonnavigable Waters.' This part discusses the nature of riparian rights, the reasonable use doctrine, some specific reasonable use controversies (such as division and detention), municipal water supply, and various aspects of pollution. Part two deals with the doctrines of public and private rights in navigable waters. Included in this part is a discussion of the development and application of rules distinguishing navigable and nonnavigable waters. Part three, on ground water, and part four, on surface water, are short, and deal with the development of law peculiar to each area. The study is a thorough examination of the water law problems of Connecticut. (Sisserson-Fla)  
W69-02866

#### NORWALK TRUCK LINE CO V VINY (RESERVATION OF RIPARIAN RIGHTS). 137 N E 2d 713 (Ct App Ohio 1956).

## Field 06—WATER RESOURCES PLANNING

### Group 6E—Water Law and Institutions

Descriptors: \*Ohio, Judicial decisions, Legal aspects, Riparian rights, \*Riparian land.  
Identifiers: Reservation of water rights.

Plaintiff's warranty deed from defendant granted full rights of egress and ingress to the property over any of the riparian and littoral rights of defendant. The giving of such rights is inconsistent with the claimed littoral rights reserved by defendant; the planned removal and leveling of land by defendant is an interference with the rights granted to plaintiff. (Molica-Fla)  
W69-02867

#### NORWALK TRUCK LINE CO V VINY (LIT-TORAL RIGHTS).

137 N E 2d 706 (C P Ohio 1955).

Descriptors: Judicial decisions, \*Ohio, Legal aspects, \*Riparian land, Riparian rights, Lakes, Gradation.  
Identifiers: Uplands.

Defendant executed a deed to plaintiffs which reserved riparian and littoral rights in the grantors. The plaintiffs sought a declaratory decree as to the littoral rights appurtenant to their upland property bordering a lake. The court held that the littoral rights are in the person having fee simple title to the land, and such rights run with the land. The reservation of the rights was not effective to defeat the littoral rights in the plaintiffs, and the defendants cannot remove land which would alter the grade elevation of the property from that existing at the time of the transfer. (Molica-Fla)  
W69-02868

#### NAVIGATION — BUOYS, BEACONS, FLOODGATES, AND DUMPING MUD OR REFUSE.

N J Stat Ann tit 2A, Para 128-2, 128-4, 128-5 (1968) 3 p.

Descriptors: \*New Jersey, \*Legislation, Water law, \*Navigation, Navigable waters, Boats, Ships, \*Buoy, Warning systems, Floodgates, Sluices, Rivers, Channels, Canals, Water pollution, Mud, Wastes, Gravels, Rocks, Legal aspects.  
Identifiers: Beacon.

Any person who moors a vessel to a buoy or beacon placed in the waters of New Jersey by any lawful authority, or willfully removes, damages, or destroys such buoy or beacon, is guilty of a misdemeanor. Likewise, any person who willfully or maliciously opens or draws up any floodgate or sluice, or does any other injury or mischief to a navigable river or canal with the intent to obstruct or prevent navigation, is guilty of a misdemeanor. Any person who deposits any mud, earth, soil, ashes, gravel, refuse, rock, or other solid substance or material into the waters of the Delaware River below the head of navigation, or into the Hudson River at any point within the state, is guilty of a misdemeanor, unless the material is deposited behind a bulkhead line or is otherwise approved by the State. (Watson-Fla)  
W69-02870

#### OPPORTUNITIES FOR REGIONAL RESEARCH ON WATER RESOURCES PROBLEMS.

Iowa Univ., Iowa City. Agricultural Law Center.  
For primary bibliographic entry see Field 06B.  
For abstract, see .  
W69-02872

#### STATE V BROOKS (PROOF OF ADVERSE POSSESSION TO MARSHLAND).

162 S E 2d 579-582 (N C Ct App 1968).

Descriptors: \*North Carolina, Judicial decisions, \*Coastal marshes, \*Land tenure, Navigable waters, Legal aspects.

Identifiers: Adverse possession.

The parties stipulated that a map on record described the property subject to title dispute in this action. The question presented was the sufficiency of the evidence with respect to defendants' claim of 30 years adverse possession. Three witnesses testified to the defendants' long, open and notorious use of certain marshland for grazing livestock, fishing and gathering shellfish. Also, a dock had been constructed for commercial purposes that extended into what is now the inland waterway. The court held that evidence at trial was sufficient to support a jury verdict for defendants and that the State was not entitled to a directed verdict on the additional complaint seeking removal of objects placed in the navigable stream. (MacMillan-Fla)  
W69-02873

#### FILLING LOW, SWAMP, AND WASTE LANDS.

N Y Village Law sec 166-b (McKinney 1966).

Descriptors: \*New York, \*Legislation, Water law, Cities, \*Swamps, Marshes, \*Landfills, Financing, Assessments, Legal aspects, Land reclamation, Local governments, Cost-benefit theory, Benefits.

The board of trustees of a village may, by ordinance, require the filling of low, swamp and waste lands within the village. If the landowner does not fill the land within the time set by the ordinance, the board of trustees will have the land filled and assess the cost against the property benefited. (Watson-Fla)  
W69-02875

#### BAILEY V ARKANSAS GAME AND FISH COMM'N (STATE REGULATION OF GAME FISH SALES).

310 S W 2d 231-239 (Ark 1958).

Descriptors: \*Arkansas, Judicial decisions, \*Fish hatcheries, Sport fish, Commercial fish, Fish conservation, Administration, Non-navigable waters, Relative rights, Riparian rights, Fish management, Legal aspects, \*Administrative decisions, Permits, \*Regulation.  
Identifiers: Constitutional law.

Plaintiff fish farmers brought this action to determine the validity of the defendant State Game and Fish Commission's regulation that forbade the sale of game fish raised along with domestic fish by plaintiffs in ponds wholly situated upon property owned by the plaintiffs. The plaintiffs also questioned the validity of a commission regulation that outlawed letting any edible portion of a game fish go to waste. The commission argued that both regulations were needed to effectively perform its duty of preserving the wildlife of the state. The Chancery Court ruled for the commission in both matters. This court, in a divided opinion, sustained the judgment with modification. The court argued that unlimited sale of privately raised game fish would work to make impossible the commission's duty to see whether or not its limits were being respected by game fishermen. Fish and fishing rights in waters entirely within private property, without means to migrate, belong to that owner; but the owner's property right is not absolute, and must yield to the state's ownership and title, held for the purpose of the regulation and preservation for public use. The commission does not, however, enjoy unlimited powers. Thus the commission may not regulate the abandonment or waste of game fish raised and taken in privately owned waters. (Blunt-Fla)  
W69-02886

#### MCDOWELL V TRUSTEES OF THE INTERNAL IMPROVEMENT FUND (OWNERSHIP OF BEDS OF A NAVIGABLE LAKE).

90 So 2d 715-718 (Fla 1956).

Descriptors: \*Florida, Judicial decisions, \*Riparian rights, Dredging, Lakes, Lake beds, Navigable waters, \*Ownership of beds, Legal aspects, Soils, Riparian land, Banks, Meanders, State governments, \*Reclamation, Public rights.  
Identifiers: Title, Sovereignty lands, Peninsula.

This is an action to enjoin the dredging of soil from a lake and to require removal of soil already dredged and used to create a peninsula. It was determined that the lake was navigable. The State holds title to lands under a navigable, meandered lake in trust for the people of the state. Owners of land bordering a navigable, meandered lake cannot acquire title to sovereignty lands under the waters of the lake by extending their land through dredging. Any lands so created are sovereignty lands. However, the refusal to grant a mandatory injunction requiring the removal of such soil was not an abuse of discretion since there was no injury to the public. (Childs-Fla)  
W69-02890

#### STRUCK V CITY OF MIAMI (CONDEMNATION OF A RIGHT OF WAY TO A PRIVATELY OWNED LAKE).

90 So 2d 600-603 (Fla 1956).

Descriptors: \*Florida, Judicial decisions, Local governments, Cities, \*Condemnation, \*Right of way, Eminent domain, Boating, Fishing, Lakes, Ponds, \*Non-navigable waters, Legal aspects.  
Identifiers: Private ownership, Public purpose.

The owner of a tract of land brought suit to enjoin a county from condemning a right of way to non-navigable lakes lying entirely within the boundaries of his property. The alleged purpose of the condemnation proceeding was to enable the public to boat and fish on the lakes. The Court held that privately owned, non-navigable lakes and ponds are not subject to any right of the public to boat or fish. A lake or pond entirely within the boundaries of a single tract of land belongs to the owner of the land. Private property can be condemned only when it will serve a public purpose and will not be permitted to encourage a trespass. The county was enjoined from further prosecuting the condemnation suit. (Childs-Fla)  
W69-02891

#### BAKER V STATE (TEST FOR NAVIGABILITY OF WATERS).

87 So 2d 497-499 (Fla 1956).

Descriptors: \*Florida, Judicial decisions, \*Navigable waters, Non-navigable waters, Streams, Intermittent streams, Meanders, Water levels, Public rights, \*Water law, Testing, Measurement, Competing uses, Water rights, Legal aspects.  
Identifiers: \*Navigable in fact, Navigable in law.

Plaintiff sued in his capacity as citizen for a declaration that he be premitted to navigate, fish, and boat on the waters of lands leased by defendants from the state. Defendants denied that the waters were navigable. The trial court held that the waters were navigable in fact. The Supreme Court reversed. The court mentioned both the federal and Florida rules relating to the navigability of waters. The federal rule is that a river is navigable in fact when it is used, or is susceptible of being used, in its natural and ordinary condition as a high-way for commerce, over which trade and travel are, or may be, conducted in the customary modes of trade and travel on water. The Florida test is that to be navigable a body of water must be permanent in character, of sufficient size, and so situated that it may be used for purposes common or useful to the public in the locality. The fact that the waters in question were meandered when the government surveys were made in 1824 does not, without more, establish navigability, especially where there is evidence tending to show that it is a small, and sometimes dry, strand. (Blunt-Fla)  
W69-02892

**MUNICIPAL CORPORATIONS: SEWER SYSTEMS.**  
For primary bibliographic entry see Field 05D.  
For abstract, see .  
W69-02895

**IVANHOE IRRIGATION DIST V MCCRACKEN.**  
357 U S 275, 78 S Ct 1174-1188 (1958).

Descriptors: \*Federal governments, Legislation, Judicial decisions, Water supply, \*Federal reclamation law, Water reuse, Arid lands, Irrigation, Federal jurisdiction, Multiple-purpose projects, \*Contracts, California, Water rights, \*Water utilization, Legal aspects.  
Identifiers: Constitutional law.

This case involved a dispute between landowners in California and the combined state and federal governments. The appellants, California landowners, contested the validity of certain contracts in connection with the huge Central Valley Project, a joint federal-state effort. The United States held the water rights in this area and entered contracts to furnish water to irrigation districts and a county agency for a period of 40 years. Pursuant to Sec 5 of the Reclamation Act of 1902, the contracts provided that water from the project could not be supplied to tracts in excess of 160 acres held by the same landowner. The contracts also provided for repayment of part of the project costs to the federal government. The landowners relied on a provision of federal law stating that the Reclamation Act was not to be construed as interfering with state law, and contended that the statute, as it was applied to the making of the contracts, was unconstitutional as a denial of due process and equal protection. The United States Supreme Court held that the provision relied upon by the landowners applied only to the acquisition of water rights and that Congress was the sole judge of the administration of projects it creates. The United States can not be compelled to deliver water upon conditions imposed by a state. (Williams-Fla)  
W69-02896

**U S V 1,000 ACRES OF LAND (CONDEMNATION FOR WATERWAY CONNECTION).**

162 F Supp 219-224 (E D La 1958).

Descriptors: \*United States, Federal governments, Louisiana, \*Eminent domain, \*Seepage, Levees, Channels, Judicial decisions, Condemnation, \*Rivers and Harbors Act, Drainage districts, Taxes, Legal aspects.

The United States brought this proceeding to condemn a strip of land for an alternate waterway connection. A commission was appointed pursuant to Federal Rule of Civil Procedure 71 A (H) to take testimony and fix the value of the property condemned. The landowners filed objections to the commission's report. The district court held that the section of the Rivers and Harbors Appropriation Act requiring that special and direct benefits to the remainder of the lot, parcel, or tract, arising from the government improvement for which the land was taken, be considered by way of reducing the amount of compensation or damages awarded, does not violate the provision of the Fifth Amendment to the Federal Constitution that private property shall not be taken for public use without just compensation. The court also held that evidence of future seepage through the levees to be erected to contain the waterway was conjectural and entitled to no weight in determining the just compensation of the landowners. (Watson-Fla)  
W69-02897

**STATE V ADAMS (OWNERSHIP OF BEDS).**  
89 N W 2d 661-688 (Minn 1957).

Descriptors: \*Minnesota, Water law, Legal aspects, \*Ownership of beds, Lakes, Streams, Navigation, \*Navigable waters, Federal government, Judicial

decisions, State governments, State jurisdiction, Surveys.  
Identifiers: \*Meandering (Legal aspects).

The State of Minnesota brought an action against several landowners to determine adverse claims to the beds of a lake and a connecting stream. On appeal, the Minnesota Supreme Court held that the evidence established that neither the lake nor the stream were navigable, and therefore title was not in the state. The court stated that upon admission to the Union, the state received title to the beds of all navigable waters, but title to the beds of non-navigable waters remained in the federal government. Federal law is to be used to determine navigability, and under such law a river is navigable if, under ordinary and natural conditions, it is susceptible to use as a highway for commerce. The fact that artificial aids must be used to make the river suitable for navigation will not necessarily mean the river is non-navigable. Also, the meandering of a lake does not determine the question of navigability, since surveyors do not have the power to determine navigability. (Williams-Fla)  
W69-02899

#### WATER-POWER COMPANIES.

Ala Code tit 10, secs 178-188 (1958).

Descriptors: \*Hydroelectric power, \*Alabama, \*Power plants, \*Condemnation, Legislation, Dams, Damsites, Right-of-way, Legal aspects, Eminent domain, Roads, Trees, State governments, Public utilities, Public rights.  
Identifiers: Ferries.

Water-power corporations operating sites in excess of 1 acre, which were not acquired by condemnation, have the power to acquire by condemnation, additional lands and rights necessary for operation and expansion. This power extends to the acquisition of land for substations and transmission lines, but, in this respect, it is limited by conflicting rights of residence owners and other power corporations. Such corporations may also acquire by condemnation the right to flood ferries and roads, rights of way for power poles and construction roads, and the right to remove timber from rights of way. In addition, any dams constructed in accordance with this article are considered authorized by the Legislature. Such water-power corporations also have all the rights of public utility corporations. Any corporation exercising the rights conferred by this article is under a duty to manufacture and sell power to the public. (Kahle-Fla)  
W69-02900

#### FLORIO V STATE (WATER SKIING NUISANCE).

119 So 2d 305-310 (2d D C A Fla 1960).

Descriptors: \*Florida, Judicial decisions, Lakes, Recreation, \*Reasonable use, \*Riparian rights, \*Water skiing.  
Identifiers: \*Nuisance.

Riparian lake owners sought to enjoin the operation of a water ski school by lessees of another riparian owner as a public nuisance. The court found that the complaint was sufficient and that the evidence established the maintenance of a nuisance. Water skiing is not a nuisance per se. Each riparian owner is entitled to reasonable use of the lake, however, and wherein owner's lawful use is unreasonable interfered with, he is entitled to injunctive relief. However, because the injunctive order was too broad and because it was not founded upon service on the members of an unincorporated association individually, the case was remanded. (MacMillan-Fla)  
W69-02903

#### OLIN GAS TRANSMISSION CORP V HARRISON (OWNERSHIP OF BEDS OF NON-

#### NAVIGABLE WATERS).

132 So 2d 721-733 (La Ct App 1961).

Descriptors: \*Louisiana, Judicial decisions, \*Non-navigable waters, \*Ownership of beds, Oil wells, Royalties, State governments, \*Navigable waters, Land tenure, Patents, Leases, Lakes, Lake beds, Canals, Riparian rights.

In concursus proceeding against the State for royalties from the sale of oil produced from wells located in a lake bed, the question of ownership of the lake bed was determinative. Louisiana contended that the lake was navigable in 1812 (date of statehood), or had since become so, and therefore the beds were owned by the State by virtue of its inherent sovereignty. Claimants traced their title to patents issued in 1901 and argued non-navigability. To be navigable at law, water must be navigable in fact, that is, used or susceptible of being used in its ordinary and natural condition as a highway of commerce. The State failed to establish navigability in 1812. Court evaluation of trial testimony affirmed the holding that the lake had not been navigable in 1812 and was not now navigable. Man-made canals in the area did not effect the question. Dicta summarized Louisiana law on aspects of bed ownership: if a body of water is navigable and has never been validly patented to an individual, the bed belongs to the State by virtue of its inherent sovereignty; if water is navigable and patented, and the patent has not been assailed pursuant to Act 62 of 1912, the bed belongs to the present title holder of record so long as the patent issued prior to the La Constitution of 1921; however, the State may acquire title when lands owned under a valid patent are inundated by navigable water. (MacMillan-Fla)  
W69-02904

#### POPULATION GROWTH AND THE DEMAND FOR WATER,

Council of State Governments; and Southern Land Economic Research Committee.

For primary bibliographic entry see Field 06D.  
For abstract, see .  
W69-02962

#### PEOPLE V KRAEMER (TRESPASSING ON LANDS SUBMERGED UNDER NAVIGABLE WATERS).

164 NYS 2d 423-435 (Pol Ct 1957).

Descriptors: \*New York, \*Ownership of beds, Judicial decision, Beds, Navigable waters, \*Public rights, Water law, Legal aspects, \*Navigation, Harbors, Boating, Legislation, Riparian land.  
Identifiers: Uplands.

Defendants were charged with violating a village trespassing ordinance by anchoring their boats over submerged land of a resident of the village, and entering on the foreshore. The area involved was a man made harbor which for years had been used by pleasure craft. Complainant alleged a violation of the ordinance based on his ownership of the uplands and land under the waters of the harbor. Defendants based their defense on two grounds: (1) that the submerged land belonged to the State, since it had never been reconveyed after cession from the crown, and (2) that, regardless of ownership, the waters are navigable and therefore subject to the public right of navigation, including anchorage and entry on the foreshore. The court rejected the first ground but accepted the second ground in part, holding that the waters were navigable, and therefore there existed a public right of navigation regardless of who owned the bed. This right of navigation is dominant. The complainant, by opening up the harbor, conferred upon the public the right of navigation. However, the court stated that entry on the foreshore was only allowable to the extent necessary to exercise the right of navigation. The one defendant who entered upon the foreshore was found guilty of a violation of the ordinance. (Williams-Fla)  
W69-02991

## Field 06—WATER RESOURCES PLANNING

### Group 6E—Water Law and Institutions

#### CUGLAR V POWER AUTHORITY (EMINENT DOMAIN BY POWER AUTHORITY TO FORM POWER POOL).

For primary bibliographic entry see Field 04A.  
For abstract, see .  
W69-02993

#### SNEED V WEBER (RIGHT OF UNITED STATES TO REMOVE OBSTRUCTIONS TO NAVIGATION COULD NOT INURE TO ANY MEMBER OF THE PUBLIC).

307 S W 2d 681-692 (Mo Ct App 1957).

Descriptors: \*Missouri, Judicial decisions, United States, Pontoons, Bridges, Lakes, \*Non-navigable waters, \*Condemnation, \*Easements, Dams, Mississippi River, Ditches, Excavation, Barriers, Public rights, Legal aspects.

Identifiers: Obstruction to navigation, Standing to sue.

Plaintiff sought to enjoin the defendants from maintaining a pontoon bridge over a lake, contending that the lake was navigable, where the United States had never exercised its right of removing obstructions to navigation on defendant's land, plaintiff, an adjoining landowner, had no cause of action concerning obstructions to navigation since the right could not inure to benefit of plaintiff or any other member of the public. The test of navigability of a watercourse is whether it is susceptible of being used, in its ordinary condition, as a highway for commerce. The burden of proving navigability is on the plaintiff. The court declared the non-navigable where a small boat could be navigated from the lake into the Mississippi River only by way of a tortuous course requiring extreme dexterity. (Childs-Fla)

W69-02995

#### MEXICO BEACH CORP V ST JOE PAPER CO (TITLE TO LANDS GAINED BY ACCRETION).

97 So 2d 708-711 (1st DCS Fla 1957).

Descriptors: \*Florida, Judicial decisions, \*Accretion (Legal aspects), \*Boundaries (Property), Gulf of Mexico, Surveys, Navigable waters, Legal aspects, State governments.

Identifiers: Plats, Land conveyance.

Plaintiff brought action to quiet title to lands formed by accretion. The trial court, in a summary decree, held for the plaintiff. The description of the land in question dated back to a federal government survey in 1833, which designated the Gulf of Mexico as one-half of the southern border of fractional section 15. Since 1833 land had formed by accretion along that border in the Gulf of Mexico. Defendant claimed that the land formed by accretion belonged to the State of Florida, the owner of fractional section 15 when the new land was formed, since Plaintiff's deed only conveyed the original fractional section 15. The court held that the Gulf of Mexico, as set forth in the original plat, still formed part of the southern boundary, and that fractional section 15 included the new land added by accretion. The court further stated that Florida follows the common-law rule which vests title to soil found along navigable waters by accretion in the owners of abutting lands. (Sisserson-Fla)

W69-02998

#### DELAUNE V BOARD OF COMMISSIONERS (APPLICABILITY OF STATUTES RELATING TO RIVERS TO LAKE PROPERTY).

87 So 2d 749-754 (La 1956).

Descriptors: Louisiana, Judicial decisions, \*Lake shores, Condemnation, Compensation, Eminent domain, Public rights, Water law, Land tenure, Legislation, \*Levees, Flood control, River regulation, Land classification, Legal aspects.

Plaintiff landowners sued the defendant levee board to recover the value of certain lakefront lands which were appropriated by defendant for construction of a flood control levee. The board filed an exception of no cause of action to the plaintiffs' petition which the trial court accepted. On appeal the board based its exception on the premise that the plaintiffs' property was burdened with a public servitude for levee construction and repair under the Louisiana Civil Code. The board further asserted that the only compensation payable for the taking of such lands was the assessed value for the preceding year. The exception of no cause of action was filed because of the failure of the plaintiffs to set forth such assessed value. This court reversed and remanded for a trial on the questions. The court held that the statute providing that public servitudes relate to the space which is to be left for public use by adjacent proprietors on navigable rivers for making and repairing levees was applicable only to navigable rivers and streams; not to lakes, as in the present case. However, the servitude imposed under the statute cited by the board is not limited to the land bordering on the river shore; rather, it covers all adjoining lands necessary to be covered for adequate flood control. How far it is from any navigable stream to the plaintiffs' lakefront land is neither averred in the petition nor shown by way of exhibit; therefore, it is impossible to ascertain whether there is a servitude for levee purposes. The payment of compensation at a rate equal to the assessed value of the land does not establish a yardstick of compensation for such lands. It is a mere gratuity, since the state has the power to take such lands without compensation. (Blunt-Fla)

W69-03000

#### LEAVING UNUSED WELL OPEN AND EXPOSED.

N C Gen Stat sec 14-287 (1967).

Descriptors: \*North Carolina, \*Legislation, Farms, \*Wells, \*Well regulations, Landfills, Legal aspects.

It is unlawful in North Carolina for any person, firm, or corporation to leave a well open and exposed after discontinuing the use of it. The well must be carefully and securely filled after the use has been discontinued. This statute does not apply to wells on farms, provided the well is protected by curbing or board walls. Any person who violates this statute is guilty of a misdemeanor and, upon conviction, may be either fined or imprisoned, in the discretion of the court. (Watson-Fla)

W69-03002

#### ERECTING ARTIFICIAL ISLANDS AND LUMPS IN PUBLIC WATERS.

N C Gen Stat sec 14-133 (1967).

Descriptors: \*North Carolina, \*Legislation, \*Islands, Water, Railroads, \*Spoil banks.

In North Carolina, by statute, if any person erects artificial islands or lumps in any of the waters of the State east of the Atlantic Coast Line Railroad, running from Wilmington to Weldon by way of Burgaw, Warsaw, Goldsboro, Wilson, Rocky Mount, and Halifax and running from Weldon to the North Carolina-Virginia State boundary by way of Garysburg and Pleasant Hill, he will be guilty of a misdemeanor. (Watson-Fla)

W69-03003

#### DUTY AS TO BRIDGES OF MILL OWNERS ON, OR PERSONS DITCHING OR ENLARGING DITCHES ACROSS HIGHWAYS.

N C Gen Stat sec 136-73 (1964).

Descriptors: \*North Carolina, Legislation, \*Bridges, Mill dams, Highways, \*Mills, \*Drainage, Ditches, Culverts, Canals, Legal aspects, Drains.

The owner of a water mill situated on any public road, and any person who constructs any ditch,

drain, or canal across any public road, must, at their own expense, construct and keep in good repair all necessary bridges. This act does not apply when the public road was constructed subsequently to the creation of the mill. (Childs-Fla)

W69-03004

#### NORTH CAROLINA SEASHORE COMMISSION.

N C Gen Stat sec 143-384, 143-388 (1964).

Descriptors: \*North Carolina, \*Legislation, \*Administrative agencies, \*Seashores, Shores, Coasts, Recreational facilities, Federal government, Recreation, Industries, Tourism, Conservation, State governments, Local governments.

The North Carolina Seashore Commission studies the development of the seacoast areas and recommends policies which will promote the preservation of the seacoast and the development of the coastal area. Particular emphasis is placed upon the development of the scenic and recreational resources of the seacoast. The Commission advises and confers with various individuals, organizations, and agencies which are interested in the development of the seacoast area, and uses its facilities in planning, developing, and carrying out programs for the development of the area as a whole. The Commission also acts as liaison between agencies of the state, local, and federal government concerned with the development of the seacoast region. The Commission is composed of 20 members and a chairman, all appointed by the Governor. (Watson-Fla)

W69-03005

#### WHITEHALL CONSTRUCTION CO V WASHINGTON SUBURBAN SANITARY COMM'N (REQUIREMENTS FOR TRESPASS ACTION).

165 F Supp 730-738 (D Md 1958).

Descriptors: \*Maryland, Judicial decisions, United States, Paving, Damages, \*Diversion to flow, \*Surface waters, Sewers, Legal aspects, Surface runoff. Identifiers: \*Trespass, \*Private nuisance.

Plaintiff brought an action for damages to paving, which collapsed because of the artificial diversion of surface waters by defendant in the course of installing a sewer. Under Maryland law, the interest interfered with in the case of 'trespass' is the exclusive possession of land, whereas in the case of 'private nuisance' it is the use and enjoyment of land. Under Maryland law, the fact that an invasion is a nuisance does not preclude it from also being a trespass. Hence the absence of an allegation that the diversion was intentional or negligent did not make the complaint subject to dismissal. The defenses of Act of God or unavoidable accident must be both pleaded and proved in order to have the complaint dismissed for failure to state a claim on which relief could be granted. The court held that the complaint was sufficient to state a cause of action. (Childs-Fla)

W69-03007

#### NADLER FOUNDRY AND MACHINE CO, INC V UNITED STATES (LIABILITY FOR CAVE-IN CAUSED BY DREDGING).

164 F Supp 249-252 (Ct Cl 1958).

Descriptors: \*United States, \*Retaining walls, \*Bank stability, \*Soil stability, Judicial decisions, Legal aspects, Bulkheads, Dredging, Navigation, Streams, Boundaries, Flooding, Channels, Damages.

Identifiers: Statute of limitations, Cave-in, Lateral support.

Plaintiff sued to recover just compensation for the taking of its land by the United States. It is alleged that the property was taken when a ship channel was dredged in a bayou so close to the low water

mark, the boundary of plaintiff's land under the law of Louisiana, that the plaintiff's soil caved into the bayou, some of its land became submerged, and the stability of other land became so endangered that the plaintiff had to build a bulkhead to preserve its stability. In dismissing plaintiff's petition, it was held that an extensive cave-in of plaintiff's land occurring in 1934 and the building by plaintiff of a bulkhead in 1935 to prevent further cave-in indicated that plaintiff at that time was aware of what would happen in the course of time. An action commenced in 1954 was therefore barred by the six year statute of limitations, even if the government's removal of lateral support prior to 1934 by dredging the channel was the cause of the cave-in. It was additionally noted that the doctrine that a private owner along a stream owns to its thread does not affect the government's easement of navigation. (Childs-Fla)  
W69-03008

#### BEAN V UNITED STATES (BENEFICIAL USE OF WATER GIVES NO VESTED RIGHT).

163 F Supp 838-846 (Ct Cl 1958).

Descriptors: \*United States, Judicial decisions, \*Water rights, Legal aspects, Rio Grande, Interstate rivers, Legislation, Administrative agencies, \*Beneficial use, Reclamation, Federal reclamation law, Riparian rights, Appropriation, \*Water contracts.

Plaintiffs sue for the taking by the United States of rights they claim in the waters of the Rio Grande River. Their properties are in the Hudspeth County Conservation and Reclamation District No. 1. The question is whether plaintiffs have any water rights with respect to the waters of the Rio Grande River which have been taken by the United States acting through the Bureau of Reclamation of the Department of Interior. The court held that waters of the Rio Grande River were delivered pursuant to contracts with the Hudspeth District that gave no vested rights to the use of the water. A beneficial use of waters gives the user no vested right. The Bureau of Reclamation had both control and the right to prescribe the use of seepage waters from lands within the Rio Grande Irrigation Project. Abandoning seepage waters does not mean that the right to use such waters in the future has been abandoned. Where, under the original contract, the Hudspeth District was given the right to use waters not used on lands of the Rio Grande Irrigation Project, and where it was not stated whether waters were unused or seepage waters and the original contract applied to seepage and drainage, no rights were acquired to those waters. (Childs-Fla)  
W69-03009

#### STEAMTUG ALADDIN, INC V CITY OF BOSTON (FEDERAL LIABILITY FOR BRIDGE AS NAVIGATIONAL HAZARD).

163 F Supp 499-502 (D Mass 1958).

Descriptors: \*Massachusetts, Judicial decisions, United States, \*Damages, \*Navigation, Hazards, Navigable waters, \*Bridges, Admiralty, Water law, Legal aspects.

Identifiers: \*Navigational obstruction.

The owner of the Steam tug Aladdin alleged that 'timber proceeding from the main part of the abutment' of the Chelsea Swing bridge struck the tug while it 'was proceeding in the Mystic River,' and that prior to that date the bridge was 'abandoned' by the City of Boston to the United States, which was 'in control of the bridge and under a duty to properly maintain, light and equip it with proper aids to navigation.' The collision was allegedly caused by the failure to display proper lights on the abutment and to remove loose planks protruding from the abutment. The court found that there was no statutory duty of the United States to maintain, light or guard against loose planks protruding from a bridge under its control. However, there is a duty imposed both at common law and in admiralty

upon persons in control of a bridge to exercise care that loose planks do not menace navigation. But, absent a statute, this duty cannot be imposed upon the United States. A civil action could be maintained under the Federal Tort Claims Act. An opportunity to amend the complaint was granted. (Childs-Fla)  
W69-03010

#### SANS V RAMSEY GOLF AND COUNTRY CLUB (USE OF LAKE ON GOLF COURSE).

50 N J Super 127, 141 A 2d 335-340 (Super Ct 1958).

Descriptors: \*New Jersey, Judicial decisions, \*Lakes, Riparian rights, Land use, \*Golf courses, \*Recreation, Non-consumptive use.

The main question in this case was whether one of the tees of defendant golf course was placed in such a manner as to unreasonably interfere with plaintiff's enjoyment of his property, thereby constituting a private nuisance. This question was resolved in favor of the plaintiff. However, plaintiff also contended that his recreational rights in a lake on the golf course were interfered with because the lake was part of a water hazard hole. The court held that where plaintiff's rights did not stem from riparian ownership, but merely from his deed, and were the same recreational rights granted to all golf course members, incidental interference with his recreational use of the lake was not actionable. It was not unreasonable for defendant to include the lake within the lay-out of its golf course. (Williams-Fla)  
W69-03012

#### WATER AND POWER RESOURCES BOARD V GREEN SPRINGS COMPANY (CONSTITUTIONALITY OF DAM PERMIT ACT).

394 Pa 1, 145 A 2d 178-187 (1958).

Descriptors: \*Pennsylvania, Judicial decisions, Legislation, \*Administrative agencies, \*Permits, Obstruction to flow, \*Dams, Streams, Non-navigable waters, State jurisdiction, State government, Streamflow, Natural flow, Dam construction, Regulation.

Identifiers: Constitutional objections.

The Green Springs Company, a fish hatchery, increased the height of its existing dam on a non-navigable stream without the consent of the Water and Power Resources Board, as was required by the Water Obstructions Act. The Board brought suit against the company for injunctive relief to force it to remove its addition to the dam and refrain from interfering with the natural flow of the stream as it had existed prior to such addition. The company defended on the ground that the Water Obstructions Act, giving the board the power to issue or withhold permits for construction of dams was an unconstitutional delegation of legislative power by the general assembly. From an adverse ruling, the board appealed. The Pennsylvania Supreme Court reversed, and held the act constitutional. The court found that the act contained sufficient guidelines or criteria for the board to follow when making its decisions on applications for permits. The court emphasized the necessity for regulation of obstructions on the stream of the state, and the fact that the legislature could not make an independent determination as to the propriety of each proposed dam. The court found that the act was passed to protect the people of the state. (Williams-Fla)  
W69-03013

#### GREENWICH WATER CO V ADAMS (EMINENT DOMAIN).

145 Conn 535, 144 A 2d 323-327 (1958).

Descriptors: \*Connecticut, Judicial decisions, Legal aspects, \*Dam construction, State governments, Flooding, Rivers, Riparian rights, \*Public utilities, Interstate rivers, Water allocation (Pol-

icy), Water distribution (Applied), \*Eminent domain, Diversion structures, Reservoirs, Reservoir storage, Reservoir field.

Identifiers: Ultra vires acts.

Plaintiff, a public service water company, sought to obtain, by eminent domain, the right to divert water from a river adjacent to defendants' land in order to increase its reservoir capacity according to a plan approved by the Public Service Commission. The contract between plaintiff and a NY water company wherein plaintiff agreed to supply water resulting from the diversion of the river to the company for 75 years is not ultra vires. The contracting parties have not attempted to allocate the waters of the interstate river for the life of the contract. They have merely made a distribution of such waters as may be impounded at the reservoir. The defendants failed to show that the contract will jeopardize the water supply of the inhabitants of Connecticut. (Molica-Fla)  
W69-03015

#### CAMP CLEARWATER V PLOCK (EASEMENT TO USE PRIVATE LAKE).

52 N J Super 583, 146 A 2d 527-540 (1958).

Descriptors: \*New Jersey, Judicial decisions, \*Ownership of beds, \*Easements, Water law, \*Prescriptive rights, Lakes, Relative rights, Public rights, Boating, Fishing, Legal aspects.

Plaintiff claimed to be fee simple owner of the bed of a small natural lake and brought suit against defendants to enjoin their use of the lake, obtain a declaration of the rights of the parties, and to recover damages for trespass to the lake. A deed to a tract bordering on the lake granted to defendants' predecessors rights to fishing and boating on the lake. Plaintiff's predecessors, owners of the dominant estate, subsequently obtained title to the servient estate, thereby merging title in the same person. Later, plaintiff's predecessors conveyed the old dominant estate to defendant's predecessors. The defendants claimed to have the same fishing and boating rights as were contained in the old deed granting the easement to their predecessors. The court held for plaintiff, stating that the merger of the dominant and servient estates extinguished the easement, and it was not revived by a subsequent conveyance of the property. Since this was a private lake, there were no public rights therein. The court stated that defendants did not gain an easement by prescription since their use was not adverse or hostile, rather being permitted by plaintiff. (Williams-Fla)  
W69-03016

#### POWERS AND DUTIES OF THE DELAWARE RIVER BASIN COMMISSION.

NY Conserv Law Sec 801, Art 3, 3.1, 3.2, 3.3, 3.4,

3.5, 3.6 (b) (c) (d) (McKinney 1967).

Descriptors: \*New York, Legislation, Administrative agencies, \*Delaware River Basin Commissions, \*Interstate compacts, Water resources development, Delaware River, State governments, Competing uses, \*River basin development, Prior appropriation, Legal aspects, Ground water.

These provisions are part of the Delaware River Basin Compact and deal with the powers and duties of the Delaware River Basin Commission. As a broad policy, the Commission shall provide for uniform and coordinated planning, development, and financing of water resources projects in the Basin. The Commission is to adopt a long range and comprehensive water resources plan and program. Water resources needs, quantitative and qualitative, are to be included. The Commission is to allocate the basin's water among the states of the compact and their political subdivisions. However, except in emergencies, it may not take any action to effect the allocation plan set up in the court decree in New Jersey v New York, 347 U S 995 (1954), unless unanimous consent of the parties to

## Field 06—WATER RESOURCES PLANNING

### Group 6E—Water Law and Institutions

such action is obtained. No allocation by the Commission is to constitute a prior appropriation, or apportionment of water. Jurisdiction of courts to hear different types of appeals from Commission orders is provided for. The signatory states waive their right to apply to the U S Supreme Court for a modification of the decree in *New Jersey v New York*, *supra*, except in a specified situation. Except as specifically provided, nothing in the compact is to be construed as impairing the decree. Various limitations on the Commission are set out. The Commission may maintain projects and establish standards therefore, conduct research, establish a system of stream and groundwater forecasting, and perform various other specified functions. (Williams-Fla)  
W69-03026

#### RIVER IMPROVEMENT DISTRICTS. N Y Conserv Law sec 611 (1) (McKinney 1967).

Descriptors: \*New York, Civil law, Legislation, State governments, Conservation, Administrative agencies, \*Water resources, \*River basin commissions, Eminent domain, Assessments, Watershed management, Legal aspects.

River improvement districts are public corporations with perpetual existence. They shall have the power to own, buy, or sell necessary real estate or other property; to sue and be sued; to incur contract liabilities; to exercise the rights of eminent domain, assessment, and taxation; and do all other things necessary to accomplish the purposes of this article. The governing body of the district shall be the Commission. Any watershed or part thereof may be created into a river improvement district. The debts, liabilities, and obligations of the district shall not be construed as those of the state; nor shall any member of the commission be personally liable for them. (Scott-Fla)  
W69-03027

#### DISCHARGE OF SEWAGE INTO WATERS (PERMITS REQUIRED).

N Y Public Health Law sec 1160, 1161, 1162, 1163, 1164, 1165, 1166, 1167 (McKinney 1954).

Descriptors: \*Sewage disposal, Sewage, Waste disposal, Riparian rights, Industrial wastes, Administrative agencies, Regulations, \*Permits, State governments, \*New York, \*Legislation, Inspection, Legal aspects, Public health, Sewers, Conduits, Effluents, Water pollution sources, Waste water (Pollution), Pipes, Streams.

The Commissioner of Public Health is empowered to issue permits allowing discharge of sewage into any waters of the State. Plans for such sewage systems must be submitted and approved by the Department. The Commissioner can issue permits for the discharge of refuse or waste matter from factories and industrial establishments into any waters of the State. One desiring to construct a conduit or discharge pipe for discharging waste matter into the State's waters is required to submit to the Commissioner a statement of purpose and plans for the conduit. If approved, a permit is issued. All of the above permits are revocable by the Commissioner upon notice, following an investigation and hearing. Each local board of health shall have a record of all permits issued in its area, and the board shall conduct inspections to insure that the limitations of sec. 1150 are adhered to. Violations are reported to the Commissioner, who, after a hearing and a determination that a violation exists, can bring an action in the name of the State against the violator. Monetary fines and penalties are provided. None of these statutes alter any common law rights of riparian owners in the quality of waters of streams covered by such rights. Sec 1168, N Y Public Health Law (McKinney Supp 1968), states that secs 1160-1167 shall be in force only until April 1, 1969. (Sisserson-Fla)  
W69-03029

#### LIABILITY RESULTING FROM ARTIFICIAL BODIES OF WATER. Iowa Univ., Iowa City.

Iowa L Rev, Vol 148 No 4 pp 939-954 Summer 1963. 15 p, 80 ref.

Descriptors: \*Judicial decisions, \*Legal aspects, Artificial watercourses, \*Iowa, Damages.  
Identifiers: Artificial bodies of water, Trespasser, \*Attractive nuisance, Liability.

A discussion of the development of the attractive nuisance doctrine is given. Case precedents are cited to show the conceptual difficulties encountered by the states in adopting a doctrine such as foreseeability and duty of care owed to a trespasser. The concepts of artificial instrumentalities (as opposed to natural) and common objects (as opposed to uncommon), used by the courts when the doctrine is raised, are the basis on which Iowa's laws of attractive nuisances involving artificial bodies of water have developed. The influence which the Restatement of Torts has had on the doctrine is discussed. In Iowa, as a matter of law, natural and artificial bodies of water are not within the scope of the attractive nuisance doctrine. (Molica-Fla)

W69-03030

#### ACTIONS BY MUNICIPALITIES TO PREVENT DISCHARGE OF SEWAGE INTO WATERS.

For primary bibliographic entry see Field 05B.  
For abstract, see .  
W69-03031

#### ORDER TO DISCONTINUE POLLUTION OF WATERS.

N Y Pub Health Law Sec 1156 (McKinney 1954).

Descriptors: \*New York, \*Water pollution sources, \*Water pollution control, Legislation, Legal aspects, Administrative agencies, Sewage, Domestic wastes, Water pollution, Public health, Pollution abatement, Waste disposal, Effluents, Inspection, Water analysis.

The Commissioner may order one discharging garbage, offal or any decomposable or putrescible matter into any waters of the state, when such discharge is polluting the waters so as to create a menace to public health or a nuisance, to show cause why such discharge should not be discontinued. A public hearing will be conducted, at which time evidence regarding the polluting activities may be presented. Following the hearing, the Commissioner may issue an order specifying the period of time after which such discharge should be discontinued and an approved method of waste disposal should be installed and in operation. The order is not valid until signed by either the Governor or the Attorney General. Section 1268, N Y Pub Health Law (McKinney Supp 1968), states that sec 1156 shall be in force only until April 1, 1969. (Sisserson-Fla)  
W69-03032

#### NAVIGATION AND FLOOD CONTROL IMPROVEMENTS IN COOPERATION WITH THE FEDERAL GOVERNMENT. N Y Gen Mun Law sec 72 L (McKinney 1965).

Descriptors: \*New York, Legislation, \*Rivers and Harbors Act, \*Flood control, \*Navigation, Watersheds, Channels, Federal government, Contracts, Easements, Right-of-way, Cities, Local governments, State governments, Dredging, Operation and maintenance.

A municipality may cooperate with the federal government in connection with the improvement of navigation and flood control or improvement and control of watersheds and waterways within its boundaries. They may furnish up to one half of the cost of such improvements. They may furnish, at no

cost to the federal government, all lands, easements, rights of way and spoil disposal areas for new work. These may be acquired through any procedure prescribed by any law relating to acquisition of real property by a municipality. They may contract with the federal government, and they may apply for grants or other financial assistance from the state or county. (Shevin-Fla)  
W69-03033

#### THE WATER-IS-DIFFERENT SYNDROME OR WHAT IS WRONG WITH THE WATER INDUSTRY, Arizona Univ., Tucson.

Maurice M. Kelso.

Proceedings of the Third Annual American Water Resources Conference (The American Water Resources Association; Urbana, Ill), c 1967, pp 176-83. 8 p, 3 ref.

Descriptors: \*Water policy, Legal aspects, Water properties, Water supply, Water allocation, Administration, Education, Social aspects, Institutions, Water shortage, Pricing.  
Identifiers: Public policy, Water images.

The water industry is ailing because its policies and institutions do not permit it to perform at the optimum of overall economic efficiency or in a manner which comes even tolerably close to best serving the public interest. The rigid, unresponsive and clumsy actions of administrative practice often hinder attempts for flexibility in water allocation. The water-is-different philosophy is the principle cause of the water industry's ailments. The image that water is unique arises in part because water is different from other resources. But the water-is-different argument ascribes to water peculiarities that go far beyond its objective idiosyncrasies. These false images help determine public policies. For example, they are largely responsible for insulating water allocation from the market mechanism. The necessary legal and governmental changes are possible only through education of the electorate and professional counselors. (Winn-Rutgers)  
W69-03137

#### SOME PHYSICAL, TECHNOLOGICAL, AND ECONOMIC CHARACTERISTICS OF WATER AND WATER RESOURCE SYSTEMS: IMPLICATIONS FOR ADMINISTRATION, New Mexico Univ., Albuquerque. Dept. of Civil Engineering.

For primary bibliographic entry see Field 06B.  
For abstract, see .  
W69-03167

#### WATER RESOURCES MANAGEMENT IN MARYLAND.

Maryland Dept. of Water Resources, Annapolis.  
For primary bibliographic entry see Field 06B.  
For abstract, see .  
W69-03170

### 6F. Nonstructural Alternatives

#### AN ECONOMIC APPROACH TO COPING WITH FLOOD DAMAGE, Resources for the Future, Inc., Washington, D. C. John V. Krutilla. Water Resources Research, Vol. 2, No. 2, 1966, pp 183-190, 2 ref.

Descriptors: Flood damages, \*Flood plain insurance, Economic efficiency, Risk, Legislation, Regulation, Financing, \*Economic feasibility, Non-structural alternatives, \*Flood protection, Flood plains.

Identifiers: Federal flood control policy.

It would appear that a significant part of the increase in the damage potential in urban flood plains is in response to the construction of work envisaged

as the primary means of flood control in the 1936 legislation. To a certain degree the benefits now claimed in justifying flood control projects are the reduction of damages to properties anticipated to be in place in the flood plain in the future. A compulsory flood loss insurance scheme would act to alleviate the existing situation in which the costs of flood damage are not distributed among those who take the risk. It would confront every individual prospect for a flood plain location, explicitly with the cost that flood plain location would entail. Insurance premiums proportional to risk and equal to both the private and social cost of flood plain occupancy would serve as a rationing device, eliminating unwarranted uses of flood plain lands, while not prohibiting uses for which a flood plain location has merit. In addition, reduction of flood loss insurance premiums can serve as a standard to measure the economic increments in scale of protective works or other non-structural flood control measures. (Gargola-Chicago) W69-02844

#### SIMILARITIES BETWEEN FLOOD CONTROL PROBLEMS AND OTHER ASPECTS OF WATER MANAGEMENT IN THE UNITED STATES,

Virginia Polytechnic Inst., Blacksburg. Water Resources Research Center.

William Walker.

Water Resources Research, Vol. 3, No. 1, 1967, pp 11-13.

Descriptors: Water quality control, \*Water resource management, Non-structural alternatives, \*Flood control, Federal government, \*Institutional constraints, Federal project policy, Administrative decisions, Pollution abatement, \*Economic evaluation, Guidelines.

In spite of the money spent on flood control, damages continue to increase every year. It has been said that the cause of it is the insistence upon building flood structures and the failure to give sufficient attention to other possible alternatives. Two major reasons for this lack of interest in alternatives are: (1) the state, local government and individuals have abdicated their responsibility in this area to the federal government; and (2) several federal agencies have vested interests in promoting and maintaining large construction programs. In the area of pollution control, these same reasons hold for the lack of consideration of alternatives. A possible solution to the problems presented in the two areas is likewise very similar. An economic evaluation should be made of the various alternatives and combinations on a basin wide plan. It thus appears that the least part of the problems associated with general water management are closely allied to the individual segments of the total picture. The approach to one phase of the water problem may provide guidelines for, or have application to, the total situation. (Gargola-Chicago) W69-02848

## 07. RESOURCES DATA

### 7A. Network Design

#### METHODOLOGICAL PREREQUISITES FOR CONDUCTING NETWORK OBSERVATIONS OF THE CHANNEL PROCESS,

N. Ye. Kondrat'yev, and I. V. Popov.

Translated from *Trudy Gos Gidrol Inst*, No 144, pp 118-150, 1967. Soviet Hydrol Selec Pap (AGU), No 3, pp 273-297, 1967. 25 fig, 2 tab, 6 ref.

Descriptors: \*Network design, \*Hydrologic data, \*Channel erosion, \*Channel morphology, Meanders, Streamflow, Sediment load, Bed load, Suspension, Model studies, Hydraulic models. Identifiers: \*USSR, State Hydrological Institute.

Recent work in the USSR on the channel processes of natural meandering streams is briefly reviewed and a system for gathering data for new studies is

proposed. Theoretical and field principles are given for planning observation networks, and model studies of channel processes are outlined. (Knapp-USGS) W69-02807

#### ANALYSIS OF WATER AND WATER-RELATED RESEARCH REQUIREMENTS IN THE GREAT LAKES REGION.

Michigan Univ., Ann Arbor.

Counc on Econ Growth, Technol, and Public Policy of the Comm on Inst Coop, 104 p, June 1968. 3 fig, 8 append.

Descriptors: \*Research and development, \*Water resources development, \*System analysis, \*Great Lakes Region, Population, Demand, Economics, Management.

Identifiers: Research needs.

Requirements for research in water and water-related fields in the Great Lakes Region, particularly in applications of systems analysis and modeling, were appraised on a regional scale. A water-quantity model of the entire Great Lakes system is necessary and feasible. Subregional, subsystem groupings are also suggested. A regional economic-growth model, water-related information systems, and a gaming-simulation model for research on institutions are also needed. Appendixes contain papers contributed to the study, conference proceedings, names of participants, and responses to a questionnaire on the research activities needed in the Great Lakes Region. (Knapp-USGS) W69-03079

#### RIVER MILEAGE MEASUREMENT,

Water Resources Council, Washington, D. C. Hydrology Committee.

Water Resources Counc Hydrol Comm Bull No 14 (rev Oct 1968), 17 p, 3 fig, 2 append.

Descriptors: \*Rivers, \*Measurement, \*Standards, Data collections, Water management (Applied), Maps.

Identifiers: \*River mileage, Nomenclature.

River mileage measurements have become increasingly important as reference points in planning and in later operations. A technique is presented for river mileage measurements that should provide a uniform approach to the determination of references. This technique has been adopted by the Water Resources Council for use in all Federal planning involving water and related land resources. Guidelines for the use of this technique by Federal agencies is also presented. Two appendices that show satisfactory formats for recording river mileages are included. (Steinhilber-USGS) W69-03100

### 7B. Data Acquisition

#### AN ELECTRIC HYGROMETER APPARATUS FOR MEASURING WATER-VAPOUR LOSS FROM PLANTS IN THE FIELD,

Western Australia Univ., Nedlands; and Botanic Gardens, St. Louis, Mo.

For primary bibliographic entry see Field 02D.

For abstract, see .

W69-02968

#### APPLICATION OF THE FINITE ELEMENT METHOD TO TRANSIENT FLOW IN POROUS MEDIA,

California Univ., Berkeley.

For primary bibliographic entry see Field 08B.

For abstract, see .

W69-03064

#### DETECTION OF SATURATED INTERFLOW IN SOILS WITH PIEZOMETERS,

Tennessee Valley Authority, Knoxville.

R. P. Betson, J. B. Marius, and R. T. Joyce.

Soil Sci Soc of Amer Proc, Vol 32, No 4, pp 602-604, July-Aug 1968. 3 p, 1 fig, 1 tab, 3 ref.

Descriptors: \*Soil water movement, \*Saturated flow, \*Subsurface runoff, \*Piezometers, Observation wells, Water levels.

Identifiers: Soil water interflow.

Piezometers were used as saturated interflow detection devices in a study of partial watershed contribution to storm runoff. Saturated interflow was detected along the AB-horizon interface in clay loam soils with shallow A horizons. The results of the study showed that at least under some soil conditions piezometers can be useful in determining the extent of saturated flow within a watershed. The occurrence of this flow will normally be confined to the shallow A-horizon regions. (Knapp-USGS) W69-03074

#### A SIMPLE EVAPORIMETER FOR USE IN COLD AREAS,

Department of Agriculture, Summerland (British Columbia). Research Station.

J. C. Wilcox.

Water Resources Res, Vol 3, No 2, pp 433-436, 1967. 4 p, 3 fig, 2 ref.

Descriptors: \*Instrumentation, \*Cold resistance, \*Antifreeze, Alcohols, Water, Air-water interfaces, Moisture content.

Identifiers: \*Evaporimeters.

An evaporimeter that uses a porous carborundum block for an evaporation surface was designed for use in cold areas where other evaporimeters freeze. The evaporating liquid is 22% methanol and 78% water and freezes at about 0 deg F. The liquid is fed by suction to a polyethylene bottle which holds the evaporation block. The instrument is suitable for use in high cold areas with difficult access. Its performance compares well with standard evaporimeters. Automatic water-level recorders permit long unattended use. (Knapp-USGS) W69-03115

#### MOVEMENT OF WATER FROM CANALS TO GROUNDWATER TABLE,

Idaho Univ., Moscow. Dept. of Civil Engineering; and Idaho Univ., Moscow. Dept. of Agricultural Engineering.

For primary bibliographic entry see Field 02G.

For abstract, see .

W69-03179

#### NON-DARCY FLOW CHARACTERISTICS OF WATER AS INFLUENCED BY CLAY CONCENTRATION,

Illinois Univ., Urbana. Dept. of Agronomy.

For primary bibliographic entry see Field 02G.

For abstract, see .

W69-03195

### 7C. Evaluation, Processing AND Publication

#### ELECTRIC-ANALOG AND DIGITAL-COMPUTER MODEL ANALYSIS OF STREAM DEPLETION BY WELLS,

Geological Survey, Denver, Colo.

For primary bibliographic entry see Field 02F.

For abstract, see .

W69-02976

#### PRECISION LYSIMETRY FOR DIRECT MEASUREMENT OF EVAPORATIVE FLUX,

Agricultural Research Service, Tempe, Ariz. Water Conservation Lab.

For primary bibliographic entry see Field 02G.

For abstract, see .

W69-02981

## Field 07—RESOURCES DATA

### Group 7C—Evaluation, Processing and Publication

**SOME COMMENTS ON THE USE OF FACTOR ANALYSES,**  
Geological Survey, Arlington, Va.  
N. C. Matalas, and Barbara J. Reiher.  
Water Resources Res, Vol 3, No 1, pp 213-223,  
1967. 11 p, 1 tab, 26 ref.

Descriptors: \*Statistical methods, \*Correlation analysis, \*Research and development, Regression analysis, Forecasting.

Identifiers: \*Multivariate analysis, \*Factor analysis.

Factor analysis is a technique that purports to explain observed relations among several variates in terms of simpler relations that provide insight into the underlying structure of the variates. The analysis, however, is technically underdeveloped, and its usefulness for studying interrelated hydrologic variates is questionable because of the inherent indeterminacies in the factor model, the lack of knowledge about the sampling properties of the factor loadings, the fact that the factors are not directly observable, and the inability to use the results of factor analyses in other analytic studies. (Knapp-USGS)  
W69-03050

**MOMENTS OF THE INPUT, OUTPUT, AND IMPULSE RESPONSE FUNCTIONS OF LINEAR SYSTEMS ABOUT ARBITRARY POINTS,**  
Technion-Israel Inst. of Tech., Haifa; and Water Planning for Israel Ltd., Tel-Aviv.

For primary bibliographic entry see Field 02A.  
For abstract, see .  
W69-03089

**REGRESSION MODELS FOR PREDICTING ON-SITE RUNOFF FROM SHORT-DURATION CONVECTIVE STORMS,**  
Agricultural Research Service, Tucson Ariz.  
Southwest Watershed Research Center.

For primary bibliographic entry see Field 06A.  
For abstract, see .  
W69-03103

**SOME ERROR PROPERTIES OF SEGMENTED HYDROLOGIC FUNCTIONS,**  
Georgia Inst. of Tech., Atlanta.

Willard M. Snyder.  
Water Resources Res, Vol 3, No 2, pp 359-373,  
1967. 15 p, 4 fig, 12 tab, 6 ref.

Descriptors: \*Mathematical studies, \*Analytical techniques, \*Hydrological data, \*Least squares method, Hydrographs, Unit hydrographs, Water yield, Rainfall-runoff relationships, Hydrograph analysis.

Identifiers: Hydrologic systems, Curve fitting.

Unknown but mathematically continuous functions can be approximated by connected linear segments. The magnitude of the largest error between segmented and continuous forms is shown to be about 2/3 of the maximum difference between arc and chord of the continuous function. This magnitude decreases rapidly with increasing number of segments. Unknown operational hydrologic functions, such as unit hydrographs or water-yield recessions, can be derived directly from observational data by the method of least squares, and the solutions for fixed segmented systems can be standardized. The form-free segmented functions are shown to be capable of better representation of data than incorrectly assumed continuous forms.  
W69-03105

**SOME USES OF A DIGITAL GRAPH PLOTTER IN HYDROLOGY,**  
Department of Energy, Mines and Resources, Ottawa (Canada), Inland Waters Branch.

G. W. Kite.

Inland Waters Br, Dep of Energy, Mines and Res Tech Bull 11, 1968. 82 p, 6 fig.

Descriptors: \*Computer programs, \*Data processing, Hydrologic data, Great Lakes region, Digital computers, Duration curves, Backwater, State-discharge relations, Surface waters, Flood routing.  
Identifiers: \*Digital graph plotter.

Detailed information is presented on the use of the digital graph plotter to give plotted output of hydrologic data. Programs, instructions for data input job set-up, plotter subroutines, and examples are given for obtaining graphic output for the following types of data compilation and analyses: (1) reservoir flood routing, (2) stage-discharge curve, (3) lake outflow, (4) backwater curve, (5) duration analysis, and (6) crustal movement. The first four programs are designed for use on the IBM 360-65 and Calcomp 663 computer-plotter combination; the last two are for the CDC 3100 and Calcomp 563 combination. A listing of additional programs being developed and a brief cost analysis are also included. (Steinhilber-USGS)  
W69-03112

**SCHEMES FOR HANDLING INCONSISTENT MATRICES,**  
Harvard Univ., Cambridge, Mass.

Myron B. Fiering.  
Water Resources Res, Vol 4, No 2, pp 291-297,  
April 1968. 7 p, 2 append.

Descriptors: \*Statistical methods, \*Data processing, Hydrologic data, Monte Carlo method, Methodology, Analytical techniques.

Identifiers: Multivariate analysis, Algorithms, Eigenspace.

The increasing role of multivariate statistical techniques, a trend based on the growing availability of computers and on pressures for streamlined representation of multidimensional arrays of data, carries with it the responsibility for using efficient techniques to manipulate matrices and arrays. It frequently happens that all records in a multivariate system (of flow records, quality measurements, or whatever) are not equally long, and that some subsets of these records do not present a consistent pattern of correlation when the entire bivariate correlation matrix is reconstructed. If one or more estimate is such that the entire correlation matrix is rendered inconsistent, repairs must be effected before continuing the multivariate analysis. Two algorithms for systematically finding a set of adjustments that satisfy the requirements of consistency are given.  
W69-03117

**A LAPLACE TRANSFORM PROOF OF THE THEOREM OF MOMENTS FOR THE INSTANTANEOUS UNIT HYDROGRAPH,**  
Technion Israel Inst. of Tech., Haifa.

For primary bibliographic entry see Field 06A.  
For abstract, see .  
W69-03120

**COLOR-INFRARED AERIAL PHOTOGRAPHIC INTERPRETATION AND NET PRIMARY PRODUCTIVITY OF A REGULARLY-FLOODED NORTH CAROLINA SALT MARSH,**  
North Carolina State Univ., Raleigh. Dept. of Botany.

For primary bibliographic entry see Field 02I.  
For abstract, see .  
W69-03177

**WHEN IS IT SAFE TO EXTEND A PREDICTION EQUATION—AN ANSWER BASED UPON FACTOR AND DISCRIMINANT FUNCTION ANALYSIS,**  
Pacific Southwest Forest and Range Experiment Station, Berkeley, Calif.

For primary bibliographic entry see Field 06A.  
For abstract, see .  
W69-03183

## 08. ENGINEERING WORKS

### 8A. Structures

#### THE FARAHNAZ PAHLAVI PROJECT.

Water Power, Vol 20, No 8, pp 305-314, Aug 1968. 10 p, 12 fig, 1 ref.

Descriptors: \*Multiple-purpose projects, River regulation, Irrigation, Flood control, \*Foreign construction, Foreign design practices, Domestic water, Seismic design, Seismic investigations, \*Buttress dams, Concrete dams, Hydroelectric power, Foundations, Outlet works, Spillways, Peak power. Identifiers: Iran, Farahnaz Pahlavi Dam (Iran), \*Seismic tests, Foreign testing.

An Iranian project designed to meet the demands of urban water supply, peak hydropower, and river regulation for irrigation is described. The Farahnaz Pahlavi Dam, a concrete buttress structure located 25 km northeast of Tehran, impounds waters of the Jaj-e Rud and Lavarak Rud flowing south from the Alborz Mountains. Topography of the site and foundation rock formations dictated design requirements o the dam. Since the dam is located in an earthquake area, much model testing was done to study behavior under seismic conditions. A powerhouse, located on the toe of the dam, has one 22.5-mw generator installed with provisions for another. Downstream irrigation water must be delivered at a uniform rate throughout the day, but electric power is needed for only a 2-hr peaking period. The project is designed to permit release of the daily irrigation water requirement through the turbines during the peaking period, for storage in a small downstream pond and continuous release as needed for irrigation. (USBR)  
W69-02911

#### PRELIMINARY SECTION OF SHAPE IN THE DESIGN OF CELLULAR DAMS,

M. D. Glezin.  
Hydrotech Constr, No 8, pp 733-737, Aug 1967. 5 p, 7 fig, 3 ref.

Descriptors: \*Cellular structures, \*Dams, \*Cells, Stress, \*Buttress dams, Design, Charts, Vertical loads, Volume, \*Dam design, Stability, Gravity dams, Foreign design practices, Concrete dams. Identifiers: Formulas, USSR.

Formulas and graphs are given for an approximation of the overall shape, stress conditions, and concrete volume of cellular dams and buttress dams with cellular buttresses, with or without soil fill in the cells. Graphs show: (1) the vertical pressure of fill transmitted to cell walls as related to cell heights and their horizontal dimensions; (2) inclination of dam faces, normal stresses at the faces, principal stresses on the downstream face, and volume of concrete for cells without fill; (3) inclination of dam faces, normal and principal stresses at the downstream face, and concrete volumes for dams with filled cells; (4) minimum principal stresses in the body of the dam with filled and nonfilled cells; and (5) isostats of minimum principal stresses with filled and nonfilled cells. (USBR)  
W69-02917

**RECENT DEVELOPMENTS IN OPTIMAL STRUCTURAL DESIGN,**  
California Univ., San Diego, La Jolla.  
C. Y. Sheu, and W. Prager.

Appl Mech Rev, Vol 21, No 10, pp 985-992, Oct 1968. 8 p, 146 ref.

Descriptors: \*Optimum design, \*Structural design, Bibliographies, Live loads, Dead loads, Design criteria, Stress, Constraints, Buckling, Loads (Forces), Plasticity, Reinforced concrete,

Prestressed concrete, Numerical method, \*Reviews.

Identifiers: Plastic design, Design assumptions, Dynamic loads.

A general but comprehensive review of literature on optimal structural design from 1963 through 1967 is given. This is an updating of a previous state-of-the-art paper published in Applied Mechanics Reviews in May 1963. The present review includes: (1) the general background of structural optimization, (2) contributions to the general methodology of the field, (3) solutions of specific problems, and (4) relevant books and expository articles. The increasing knowledge in this field is demonstrated by the fact that the present paper, covering only 5 yr, has more than half the number of references included in the first review, covering the period from Galileo to the end of 1962. (USBR)

W69-02932

#### STRUCTURAL DESIGN—GRAND COULEE

#### THIRD POWERPLANT,

Bureau of Reclamation, Denver, Colo.

H. Walter Anderson.

Preprint 747, Amer Soc Civ Eng Annual Meet Nat Meet Struct Eng, Pittsburgh, Pa., Sept/Oct 1968. 38 p, 17 fig, 5 ref.

Descriptors: \*Structural design, \*Structural analysis, Design tools, Structural stability, Computer programming, Hydrostatic pressure, Digital computers, \*Stability analysis, Dead loads, Reinforced concrete, Live loads, Deformation, \*Powerplants.

Identifiers: \*Computer-aided design, Computer printouts, Time sharing, Problem-oriented languages, Grand Coulee Powerplant (Wash.).

Structural design studies are currently underway for the largest hydroelectric powerplant in the world. Design of the Third Powerplant structure requires a wide variety of structural analyses. Virtually all of these analyses are being performed with the assistance of digital computers by a design team of structural engineers well versed in computer programming. Time-sharing computers are used to perform, in minutes, studies similar in scope to those once performed manually in days. Comprehensive analyses that consider the behavior of the entire structure are being performed that could not be accomplished without the availability of large-scale computer systems. The scope of these studies and the digital computer programs being used to accomplish them are described. Results drawn by an indeterminate structural analysis program on a cathode-ray-tube are shown for a comprehensive analysis of the downstream galleries and piers. Computer programming techniques, including a program used to write programs, are discussed. (USBR)

W69-02939

#### NUCLEAR REACTORS: STATUS AND FUTURE TRENDS,

Atomic Energy Commission, Washington, D. C.; and United Engineers and Constructors, Inc., Philadelphia, Pa.

F. E. Rutt, and W. C. Siler.

Preprint 732, Amer Soc Civ Eng Annual Meet Nat Meet Struct Eng, Pittsburgh, Pa., Sept/Oct 1968. 21 p, 3 fig.

Descriptors: \*Nuclear powerplants, Planning, Nuclear reaction, Design, Construction, \*Electric power production, Electric power costs, Electric power, Electric power demand, Atmospheric pollution, Water pollution, Safety, Radioactivity, Thermal radiation, Aesthetics, Peak power, Cost comparisons, Capital costs, Cooling water, \*Nuclear reactors.

Identifiers: Electric utilities, Fossil fuels, Nuclear fuels, \*Nuclear technology, \*Nuclear safety.

Power reactor construction is placing a strain on the utility, manufacturing, and construction indus-

tries as well as on Federal and state regulatory agencies. Utility companies are required to make increasingly complex decisions as to type, size, and location of new generating facilities. Larger plants and escalating costs require that special attention be given to financial planning. Organizations engaged in design and construction of nuclear- and fossil-fueled powerplants are experiencing pressures on their resources. Design of many large-size units is placing a critical strain on the supply of experienced power-plant engineers, designers, and draftsman. Increasingly complex state and Federal regulatory requirements also demand additional engineering work. Increased demand and escalating quality control requirements are placing greater pressures on field construction forces and skilled labor categories. Projections of future demand for electric-generating capacity require special attention by various segments of private industry and government, directed toward developing advanced concepts and new power sources. The status of development of several advanced concepts and future power sources are reviewed. (USBR)

W69-02940

#### SAFETY FACTORS AND PROBABILITY IN STRUCTURAL DESIGN,

Illinois Univ., Urbana.

Alfredo H. S. Ang, and Mohammad Amin.

Preprint 708, Amer Soc Civ Eng Annual Meet Nat Meet Struct Eng, Pittsburgh, Pa., Sept/Oct 1968. 28 p, 6 fig, 2 tab, 16 ref, 4 append.

Descriptors: \*Safety factors, \*Structural design, \*Safety, Structures, Probability, Structural engineering, Structural models, Design, Design criteria, Structural stability, Structural behavior, Reliability, Mathematical analysis, Evaluation, Bibliographies.

Identifiers: Design assumptions.

An alternative formulation of structural safety is proposed, and its associated basis for designing safe structures is described. The proposed formulation combines certain aspects of the conventional design method with an extended reliability theory in such a manner as to capitalize on the best features of each method. In so doing, the major shortcomings and difficulties previously associated with existing methods, including the critical problem of choosing an acceptable probability level for design, can be resolved more easily. Practical significance includes the feasibility of developing workable design procedures based on the reliability concept but retaining the simplicity of the conventional method. The proposed approach is described in its most basic form and illustrated with simple examples. This presents the fundamentals of the new approach more clearly. Ramifications, and possibly extensions, of the basic formulation will be necessary to implement the proposed safety concept in practical design situations; studies for this purpose are in progress. (USBR)

W69-02941

#### STRESS AND STRAIN ANALYSIS ON MODELS,

Lazar Jovanovic.

Saopstenja, Vol 14, No 41-42, pp 69-82, 1967. 14 p, 14 fig, 15 ref.

Descriptors: \*Model tests, \*Structural models, Models, \*Structural behavior, \*Stress analysis, \*Structural analysis, Hydraulic structures, Dams, Dam foundations, Abutments, Buttress dams, Gravity dams, Arch dams, Concrete dams, Concrete structures, Foreign design practices, \*Photoelasticity, Strain gages, Tensiometers, Bibliographies.

Identifiers: Yugoslavia, Photoviscoelasticity, Bajina Basta Dam (Yugoslavia), Idbar Dam (Yugoslavia), Modrac Dam (Yugoslavia).

Model testing of dams and hydroelectric structures at the Jaroslav Cerni Institute is surveyed. Developments in model testing are being made primarily in photoelasticity, tensiometry, and brittle coatings. Photoelastic studies are described on the 2-dimen-

sional problem of weakening of gravity dams by galleries, 3-dimensional stress analysis of dams and foundations, fissured and anisotropic dam foundations, and analysis of concrete structures. Developments in the use of photoviscoelastic materials, photothermoelastic studies, and photoelastic coatings are discussed. Tensiometric models of dams and the dam terrain complex are given for Bajina Basta buttress dam, Idbar arch dam, and Modrac multiple-arch buttress dam. Brittle coatings are used as a preliminary method of determining stress trajectories for locating strain gages in tensiometric testing and also in dynamic tests of parts subjected to impacts. Experiment stress and strain analysis is accepted as a necessity and has become a permanent practice in constructing important structures in hydroengineering and other branches of civil engineering. (USBR)

W69-02948

#### CONCRETE RESERVOIR DESIGN,

Montgomery (James M.) Construction Engineers, Inc., Pasadena, Calif.

Russel C. Kenmir.

J Amer Water Works Ass, Vol 60, No 10, pp 1181-1194, Oct 1968. 14 p, 14 fig, 1 tab.

Descriptors: \*Reservoir design, \*Reservoir construction, \*Underdrains, Aesthetics, Design criteria, Reservoir leakage, \*Reservoirs, Prestressed concrete, Construction joints, Maintenance costs, Reservoir sites, Water storage, Linings, Precast concrete, Reinforced concrete, Costs, Post tensioning, Cost comparisons, Foundation investigations.

Identifiers: Concrete linings, Concrete properties.

Concrete reservoirs involve a multitude of details that must be designed and constructed properly. These details, which can cause costly maintenance problems, include: location of construction joints, installation of water stops, vibration and curing of concrete, and design and construction of underdrains. Concrete reservoir walls may be non-prestressed, prestressed, or post-tensioned. The roof may be either cast-in-place or precast design. Aesthetics and relation of the site elevation are important factors in selecting the reservoir type. Some general precautions are given to reduce the possibility of trouble with wire-wrapped prestressed reservoirs. Buried reservoirs are becoming more attractive to water utility agencies because of rising cost of land and savings in maintenance expense. A tabulation of construction cost data on various types of concrete reservoirs is given. The need for a foundation investigation, including underdrains, is discussed. Construction joints should be spaced about 20-30 ft in reinforced concrete and 10-12 ft in unreinforced concrete. The quality of concrete necessary to obtain a watertight and maintenance-free reservoir is discussed. (USBR)

W69-02952

#### 8B. Hydraulics

##### INFLUENCE OF SIDE SPILLING FLOW IN A COLLECTING CHANNEL,

Georgije Hajdin.

Saopstenja, Vol 14, No 43, pp 5-12, 1967. 8 p, 7 fig, 1 tab, 3 ref.

Descriptors: Channels, \*Water collection systems, Open channel flow, \*Open channels, Hydraulic structures, Foreign design practices, Fluid flow, Hydraulics, Vortices, Fluid mechanics, Canal design, Submergence, Spilling, Flood control, Floodwater, Inflow, \*Spillways, Spillway crests.

Identifiers: \*Side channel spillways, Channel design, Yugoslavia.

Floodwater is commonly evacuated by side spilling into a collecting channel. This type of inflow can make solution of the linear flow problem impossible because longitudinal flow may be disturbed by inflows and, therefore, cannot be considered linear. Conditions were determined for longitudinal flow

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### Group 8B—Hydraulics

in a collecting channel without unpermissible lateral influences. Two cases of side spilling inflow include: nonsubmerged spill stream penetrating the collecting channel and forming 2 vortices which nearly expend the kinetic energy of the spill; and submerged spill stream quickly advancing as a surface wave, which increases discharge while the return wave submerges the spill downstream. Spill submerging should be prevented. The transverse cross section of the channel can be determined to be sufficiently large for damping the lateral inflow only under conditions of nonsubmerged spilling. The practical problems analyzed are: (1) cross-section conditions of the channel allowing longitudinal flow without great disturbance from lateral inflow, (2) extra height required on the nonspilling side, and (3) conditions for preventing spill submergence. Instructions are given for designing collecting channels with side spill inflows. (USBR)  
W69-02945

**MEASUREMENT OF HYDRAULIC AND SEDIMENT TRANSPORT VARIABLES IN A SMALL RECIRCULATING FLUME,**  
Geological Survey, Fort Collins, Colo.  
For primary bibliographic entry see Field 02J.  
For abstract, see .  
W69-03056

**APPLICATION OF THE FINITE ELEMENT METHOD TO TRANSIENT FLOW IN POROUS MEDIA,**  
California Univ., Berkeley.  
Iraj Javandel, and P. A. Witherspoon.  
Soc of Petrol Eng J, Vol 8, No 3, pp 241-252, Sept 1968. 12 p, 9 fig, 34 ref, 1 append.

Descriptors: \*Unsteady flow, \*Porous media, \*Mathematical studies, Digital computers, Approximation method, Hydraulic conductivity.  
Identifiers: \*Fluid flow, Finite element method, Layered systems.

The extension of the finite element method (which was developed to handle stress distribution problems in airframe construction) to problems of transient flow in porous media is described. The method provides a new approach to problems of transient fluid flow in complex systems. In this approach, the continuum is replaced by a system of finite elements. By employing the variational principle, one can obtain time dependent solution for the potential at every point in the system by minimizing a potential energy functional. The theory of the method is reviewed. To demonstrate its validity, nonsteady-state results obtained by the finite element method are compared with those of typical boundary value problems for which rigorous analytical solutions are available. To demonstrate the power of this approach, solutions for the more complex problem of transient flow in layered systems with crossflow are also presented. The generality of this approach with respect to arbitrary boundary conditions and changes in rock properties provides a new method of handling problems of fluid flow in complex systems. (Knapp-USGS)  
W69-03064

**DESIGN OF STABLE CHANNELS IN ALLUVIAL MATERIALS,**  
Kansas State Univ., Manhattan; and Colorado State Univ., Fort Collins.  
R. M. Haynie, and D. B. Simons.

ASCE Proc, J Hydraul Div, Vol 94, No Hy6, Pap 6217, pp 1399-1420, Nov 1968. 22 p, 14 fig, 3 tab, 42 ref.

Descriptors: \*Alluvial channels, \*Canals, \*Design criteria, Roughness (Hydraulic), Channel morphology, Bed load, Sediment discharge, Reynolds number, Stokes law, Settling velocity, Mississippi River.  
Identifiers: \*Stable channels.

Data from flume experiments, river sediment discharge observations, and canal operation observations were used to compile design criteria for stable alluvial channels. The suggested design method considers bed roughness, flow resistance, bed load discharge and channel geometry. An alluvial channel is designed using discharge, fall diameter, type and geometry of bed material, and water temperature data. (Knapp-USGS)  
W69-03066

**DEPOSITIONAL BEHAVIOR OF KAOLINITE IN TURBULENT FLOW,**  
Massachusetts Inst. of Tech., Cambridge; and State Univ. of New York, Buffalo.  
For primary bibliographic entry see Field 02J.  
For abstract, see .  
W69-03067

**RUNOFF HYDROGRAPHS FOR MATHEMATICAL WATERSHED MODEL,**  
Minnesota Univ., St Paul. Dept. of Agricultural Engineering.  
For primary bibliographic entry see Field 02E.  
For abstract, see .  
W69-03070

**AN EXPERIMENTAL RAINFALL-RUNOFF FACILITY,**  
Colorado State Univ., Fort Collins.  
For primary bibliographic entry see Field 02A.  
For abstract, see .  
W69-03076

**OPTIMIZATION OF PRESSURE CONDUIT SIZES,**  
D. I. H. Barr.  
Water Power, Vol 20, No 5, pp 193-196, May 1968. 4 p, 7 fig, 13 ref.

Descriptors: \*Optimization, \*Pressure conduits, Size, Analytical techniques, Water conveyance, Hydraulic design, Hydraulic gradient, Pumping, Head loss, Roughness (Hydraulic), Costs.

Various methods of determining pressure conduit sizes were reviewed and discussed. The methods used graphical techniques based on several mathematical approaches (e.g. Lagrange's method of undetermined multipliers). Most of the methods determined the optimum diameter by finding the minimum total 'pumping' plus 'conduit' costs, hydraulic friction losses being computed by the Manning Equation. (Gysi-Cornell)  
W69-03148

## 8C. Hydraulic Machinery

**THE INFORMATION BACKGROUND IN THE FIELD OF BIOLOGICAL DETERIORATION OF NONMETALLIC MATERIALS,**  
Thompson (John I.) and Co, Washington, D. C.  
Carl J. Wessel.

Mater Res Stand, Vol 8, No 9, pp 11-17, Sept 1968. 7 p, 8 fig, 7 tab, 1 ref.

Descriptors: \*Deterioration, Directories, Documentation, \*Information retrieval, Materials, Materials stability, \*Nonmetals, Tropical regions, Biocorrosion, Organic compounds, Microorganisms, Bibliographies, Inorganic compounds, \*Biodegradation, Biological treatment, \*Corrosion, Corrosion control, Fungi.  
Identifiers: Microbes, Information centers, Technical papers.

The background and development of the field of biological deterioration of nonmetallic materials are reviewed. Sources of literature on biodeterioration are discussed, including the literature collection of the Prevention of Deterioration Center. Documentary materials are classified as primary materials, secondary sources, and information center sources. A list is given of primary journals,

announcement bulletins, abstracting and indexing journals, and information centers. These information sources are important to the needs of research, development, test, and evaluation in the biodeterioration field. (USBR)  
W69-02905

**TUBULAR TURBINES,**  
Washington State Univ., Pullman.  
Robert A. Sutherland.

Washington State Univ, Bull 309, 1968. 49 p, 23 fig, 1 tab, 69 ref.

Descriptors: Hydroelectric power, \*Tidal powerplants, \*Bulb turbines, Efficiencies, \*Tube turbines, Economics, Pump turbines, Bibliographies, Mechanical engineering, Hydraulic turbines, Kaplan turbines, Turbines, History, Thrust bearings, Electric generators, Hydraulic machinery.

Identifiers: Rance Tidal Project (France), Moselle River, \*Low-head hydro plants.

The tubular turbine was invented in the United States but has been largely developed in Europe. It has many advantages for the economical development of low-head hydropower up to a head of approximately 60 ft and a power of 35 mw. Flow is nearly straight through, resulting in improved efficiency and reduced lateral and vertical dimensions as compared with conventional turbine-generator units. The generator is usually located in a bulb-shaped enclosure supported within the water passage, but with appropriate access. Another design locates the generator outside the water passage, with the disadvantage of a longer shaft. In either design the generator may be gear driven at a higher speed than the turbine. The tubular turbine generally uses a Kaplan-type runner, and in several cases has been used for pump and turbine services. It is well suited for tidal power and is the basis of the Rance tidal development in France. Charts are given for finding the approximate runner diameter; rules of thumb are applied to determine approximate dimensions of a complete unit for comparison with a conventional unit. A table lists characteristics of 94 worldwide tube turbine installations. (USBR)  
W69-02907

**CAVITATION TESTS OF A MODEL OF THE RADIAL GATE OF THE BOTTOM OUTLET OF THE KRASNOYARSK HYDROELECTRIC STATION DAM,**  
Yu A. Grivnin.  
Hydrotech Constr, No 8, pp 704-709, Aug 1967. 6 p, 9 fig, 1 tab, 9 ref.

Descriptors: \*Radial gates, \*Cavitation, \*Outlet works, Model tests, Foreign research, Hydraulic structures, Hydraulic design, Pressure head, Stainless steel, Experimental data, Flow, Velocity.  
Identifiers: Cavitation noise, Cavitation resistance, Cavitation index, USSR, Krasnoyarsk Dam (USSR), Gate guides, Gate sills.

Cavitation tests were conducted on models of the bottom outlet radial gates at Krasnoyarsk Dam. Tests showed that all modes of gate operation were accompanied by cavitation in the corners of the drop, and that intensity increased with rise of the upper pool level and an increased gate opening. Cavitation erosion appeared to be greatest at the corners of the drop, the gate guides, the sill, and the floor of the conduit behind the sill. Cavitation erosion could be decreased by: (1) rounding the edge of the gate drop, (2) introducing air into the zone behind the sill, and (3) lining gate guides with stainless steel. Because of little knowledge of the scale effect, cavitation under field conditions in prototype gates will be more intense than in the model tests. Results of model tests are reported. (USBR)  
W69-02914

**HORIZONTAL BORING TECHNOLOGY: A STATE-OF-THE-ART-STUDY,**  
Bureau of Mines, Minneapolis, Minn.

James Paone, William E. Brucé, and Roger J. Morrell.  
Bur Mines, Inform Circ 8392, Sept 1968. 86 p, 63 fig, 14 tab, 69 ref, append.

**Descriptors:** Boreholes, \*Boring machines, Borings, Tunneling, Drills, \*Tunneling machines, Tunnels, Rock excavation, Drill holes, Transmission (Electrical), \*Drilling equipment, Auger borings, Augers, \*Transmission lines, Bibliographies, Reviews, Rocks, Soils, Direction finding, Drives, Surveying, Plowing, Trenches, Excavation, Reamers, Penetration.  
**Identifiers:** \*Underground cables, \*Underground transmission lines, \*Buried cables.

Horizontal boring technology for underground power transmission is reviewed in this state-of-the-art report prepared by the Bureau of Mines. Machines and methods are described for augering, impacting, pushing, drilling, and machine tunneling of horizontal holes through soil and rock. Borehole survey and guidance tools and applicable techniques are reviewed. Nonboring methods for emplacing power distribution and transmission lines are covered. Horizontal boring techniques for burying power distribution lines are adequate for industry requirements, particularly for short distances in soil or soft rock. Horizontal boring methods are not as well advanced for burying power transmission lines, particularly in hard rock and over relatively long distances. Research and development and economic incentives to equipment manufacturers could substantially improve the state of the art. Obstacle detection and guidance systems for directing boreholes need major improvements to meet power industry requirements for underground burial of distribution and transmission lines. The report gives a technical forecast, an analytical summary of the state of the art, and recommendations based on power industry needs. (USBR)  
W69-02923

**EVALUATION OF SPACERS FOR BUNDLED CONDUCTOR TRANSMISSION LINES,**  
Bureau of Reclamation, Denver, Colo.  
R. A. Krahn, and M. B. Bessler.  
No 69 CP 8-PWR, Inst Elec Electron Eng Winter Power Meet, New York, N Y, Jan 1969, Oct 1968. 5 p, 6 fig, 1 ref.

**Descriptors:** Extra high voltage, \*Bundled conductors, \*Spacers, Field tests, \*Transmission lines, Dampers, Vibrations, Materials engineering, Abrasion, Test procedures, Arizona, Laboratory tests, Reliability.  
**Identifiers:** \*Transmission line hardware, Electric conductors, Test results, Antelope Hills Test Area, Product evaluation.

The increasing use of bundled conductors on ehv transmission lines requires close scrutiny of spacer reliability and effectiveness. A transmission line hardware test section was established on an operating circuit to evaluate new spacer and damper designs. Results have revealed problems of conductor abrasion and the loss of clamping force in spacer clamps. Preliminary results of a continuing test program are discussed, with emphasis on significant questions yet to be answered. Evaluation of line hardware may become more important with the evolution of multibundle, uhv transmission lines that follow the trends of present design. An intense appraisal of today's hardware design problems will aid in a better-engineered product to meet the rigors of increased loadings, lightweight materials design, and the complex nature of transmission line vibration. (USBR)  
W69-02943

**OPTIMIZATION OF TIDAL POWER GENERATION,**  
For primary bibliographic entry see Field 06A.  
For abstract, see .  
W69-03160

## 8D. Soil Mechanics

**DYNAMIC LOADINGS,**  
D'Appolonia (E.) Consulting Engineers, Inc., Pittsburgh, Pa.  
E. D'Appolonia.  
Amer Soc Civ Eng Spec Conf, Massachusetts Inst Tech, Cambridge, Aug 1968. 46 p, 14 fig, 4 tab, 53 ref.

**Descriptors:** Dynamics, \*Soil dynamics, Soil liquefaction, Strain, Soil treatment, \*Soil density, Settlement, Bibliographies, Earthquakes, Earth dams, Design criteria, \*Foundations, Embankments, Soil mechanics, Shear stress, Drainage, Relative density, Granular materials, Shear strength.  
**Identifiers:** \*Dynamic loads, \*Dynamic response, Confining pressure, Soil-structure interaction.

Criteria for placing and improving soil required to sustain dynamic loadings should be determined for each specific case from an evaluation of the soil and structure response to ground motion. Soil density and confining pressure are the 2 most important considerations for fill supporting structures other than fluid impounding embankments. In the latter case, drainage, density, and confining pressure are the most important aspects, in that order. High-magnitude ground motions of short duration cause little distress to structures. Soil for machinery foundations should be compacted to a depth 1.5 times the average width of the foundation and in an annular distance around the foundation equal to at least one-half the average foundation width. To reduce the risk of liquefaction, granular soil should be densified to a relative density of 85% in the upper portion of the deposit and 70% within the zone of influence of the foundation. To preclude liquefaction at all depths, the cyclic stress required to produce initial liquefaction should be at least 1.5 times the dynamic shear stress caused by the design earthquake; cyclic stress required to produce liquefaction at 10% strain should be at least equal to the dynamic stress from the maximum credible earthquake. (USBR)  
W69-02908

**TWO-DIMENSIONAL ANALYSIS OF STRESS AND STRAIN IN SOILS, REPORT 5; PLANE-STRAIN LOADING OF A STRAIN-HARDENING SOIL,**  
Massachusetts Inst. of Tech., Cambridge.  
W. H. Tang, and Kaare Hoeg.  
Army Eng Waterways Exp Sta Contract Rep No 3-129, Mar 1968. 84 p, 26 fig, 2 tab, 9 ref, 4 append.

**Descriptors:** \*Footings, Strain, Mathematical analysis, Soil mechanics, Mathematical models, Numerical analysis, Stress-strain curves, \*Flexible foundations, Stress circle, Stress distribution, \*Settlement, Elasticity modulus, Plastic deformation, Elastic deformation, Foundations, Computer programming, Internal friction, Soil dynamics, Cohesion, \*Live loads.  
**Identifiers:** \*Strain hardening, Plane strain, Dynamic response, Dynamic loads.

Idealized stress-strain relationships for a strain-hardening soil are formulated and discussed. The method was applied to a flexible 5-ft-wide strip footing resting on frictional material with unit weight of 119 lb/cu ft. To perform the numerical computations, the soil continuum was replaced by a lumped parameter model. If plastic volume change of the soil element takes place during virgin loading, the element is work-hardened. Upon subsequent reloading, no plastic straining will occur until a stress state is reached, bringing the stress up to the previous yield surface. Analysis of the strip footing statically loaded to 35.8 psi indicated that a failure pattern was developing. Decrease in settlement was proportional to the increase in elastic modulus. Because of the inertia of the assumed 2-ft-thick concrete footing, the ratio of peak response

to peak applied footing pressure during impulse loads is about 1.35 and occurs after 45 msec. As friction angle and cohesion are increased, displacements are increased, indicating an inadequacy in the present formulation of strain-hardening behavior. (USBR)  
W69-02912

**EVALUATION OF VIBRATORY ROLLERS ON THREE TYPES OF SOILS,**  
J. W. Hall.

Army Eng Waterways Exp Sta Tech Memo No 3-271, Mar 1968. 39 p, 9 plate, 5 tab.

**Descriptors:** Vibrations, Compacted soils, \*Compaction, \*Rollers, Soil density, \*Compaction equipment, \*Compaction tests, Frequency, Moisture content, Sands, Clays, Crushed stones, Lifts (Construction), Evaluation, \*Soil compaction, \*Construction equipment, Soil mechanics.  
**Identifiers:** \*Vibratory compaction.

Compressive effort of 3 vibratory rollers is compared to that of a 50-ton rubber-tired roller. Operating frequencies of the 3 rollers encompass the range over which present vibratory rollers operate. Each of the 3 rollers was used to compact 3 soil types: lean clay, crushed limestone, and clean sand. Each soil was compacted wet of, dry of, and at optimum moisture content. Density in sand compacted with vibratory rollers appears to be a cyclic function of coverages. The lowest frequency compactor performed the best in sand. Densities in limestone and lean clay generally increased in direct proportion to the deadweight of vibratory rollers. Except in limestone, vibratory rollers will not produce densities to significantly greater depth than rubber-tired rollers. For comparable lift thickness of compaction, much lighter vibratory rollers may be substituted for heavy rubber-tired rollers; however, there is a limit to the amount of weight reduction that can be achieved using vibratory rollers. (USBR)  
W69-02915

**FIELD INVESTIGATIONS OF SEEPAGE ON EXISTING DAMS,**  
O. N. Nosova, and G. M. Zadvornyi.

**Descriptors:** \*Seepage, \*Dams, Field investigations, \*Underseepage, Percolation, Foundation investigations, Pervious soils, Piezometers, Tracers, Foreign design practices, Sedimentation, Radioisotopes.  
**Identifiers:** Piping (Erosion), USSR.

A discussion is given of investigation and treatment of underseepage problems in general and, in particular, those occurring at the Ust'-Kamenogorsk, Kama, Uch-Kurgansk hydroelectric dams in the USSR. Dams can be constructed safely on porous foundations, provided proper foundation treatment is given to prevent underseepage or piping. When planning a dam on a river carrying a large amount of sediment, the possibility should be considered of forming (by sedimentation) a natural apron in the riverbed and reservoir bottom upstream from the dam. The cost of seepage control can be reduced by this measure. (USBR)  
W69-02921

**LOAD TRANSFER--BEARING CAPACITY FOR SINGLE PILES AND PILE CLUSTERS,**  
D'Appolonia (E.) Consulting Engineers, Inc., Pittsburgh, Pa.  
E. D'Appolonia.  
Amer Soc Civ Eng, Soil Mech Found Div, Illinois Sect, Apr 1968. 78 p, 31 fig, 3 tab, 74 ref.

**Descriptors:** Bearing capacities, \*Pile groups, \*Pile foundations, Pile lateral loads, Negative friction, Ultimate loads, Bibliographies, Safety factors, Pile spacing, Pile friction, \*Pile (Foundations), \*Pile bearing capacities, Pile extraction, Load distribution, Design criteria, Skin friction, Instrumentation, Foundations.

## Field 08—ENGINEERING WORKS

### Group 8D—Soil Mechanics

Identifiers: Pile tests, Loading tests, Pile-driving formulas.

Apparent success with pile foundations has not resulted from knowledge of pile-soil behavior but is a consequence of a conservative approach to design and installation. The design of a pile group is based on experience with similar pile installations and load deformation behavior of a single pile. Applications and limitations of pile driving formulae are discussed. Theoretical load transfer assumes that the pile remains linearly elastic throughout the entire range of loading and that it is embedded in a semi-infinite elastic solid. If strains are small (comparable to those of elastic shortening of the pile), techniques based on compatibility of deformations and linear stress-strain relations can be used to predict load transfer from a pile and movement of its tip. Factors of safety should be applied to skin resistance and end bearing capacity. Two examples are given of tension-compression tests used to determine end bearing capacity and skin friction of piles. The relation between ultimate load capacity and settlement of single piles and pile groups is discussed. (USBR)

W69-02922

#### MECHANICAL PROPERTIES OF COMPAKTED SOILS,

Ohio State Univ., Columbus.

Charles A. Pagen, and Banad N. Jagannath.  
Highw Res Rec, No 235, pp 13-26, 1968. 14 p, 9 fig, 1 tab, 12 ref.

Descriptors: \*Compacted soils, Unconfined compression, Soil mechanics, Rheology, \*Compaction, \*Mechanical properties, \*Soil compaction, Elastic deformation, Soil compression tests, Soil density, Soil properties, Soil strength, Subgrade, Deformation, Stress-strain curves, Moisture content, Thixotropy, Elasticity modulus, Creep.

Identifiers: Subgrade modulus, Viscoelasticity.

At low stress and strain levels, compacted soils can be described as linear viscoelastic materials. Response of highway subgrade materials is described by fundamental strength properties that can be utilized to evaluate changes in strength and deformation characteristics of soils produced by the type and amount of compaction energy applied. Four soils representative of the natural soils used for highway subgrades were investigated. Experiments were performed to investigate the application of the linear viscoelastic theory and mechanistic models to unsaturated soils and to determine limitations of such approaches to highway compaction problems. Three to 5 levels of impact compaction energy were used to prepare test specimens over a range of molding water contents. The unconfined constant-load creep test investigated mechanical properties of compacted soils on the phenomenological level. Failure tests were performed to evaluate modulus of deformation and ultimate unconfined compressive strength. The study utilized the electric-mechanical analogy and concept of complex elastic modulus to define mechanical properties of compacted soils. Data were obtained to validate the evaluation of soil compaction by rheological strength parameters. (USBR)

W69-02925

#### EVALUATION OF DEEP IN-SITU SOIL STABILIZATION BY HIGH-PRESSURE LIME-SLURRY INJECTION,

Swindell-Dressler Co., Pittsburgh, Pa.  
H. L. Lundy, Jr., and B. J. Greenfield.  
Highw Res Rec, No 235, pp 27-35, 1968. 11 p, 9 fig, 4 photo, 13 ref.

Descriptors: \*Soil stabilization, \*Shear strength, Moisture content, Soil physical properties, \*Soil treatment, \*Slurries, Atterberg limits, \*Lime soil mixtures, Lime, Glacial deposits, Glacial soils, Silts, Soil mechanics, Foundations, pH, Soil engineering, Injection.

Identifiers: Soil plasticity.

A soft glacial clayey silt deposit was pressure-injected with a hydrated lime slurry to depths of 20 ft to determine the effects of lime stabilization on the foundation beneath a 40-ft highway embankment. Treated and untreated lime samples taken up to 1 yr after the injection are discussed. The slurry was a mixture of 30% lime and 70% water by weight and was injected at pressures of 300 and 600 psi. Eight to 12 gal of slurry were injected every 8-1/2 in. of depth. Slurry loss around the injection rod indicated that the lime did not penetrate softer soil to the extent that it did the harder postglacial material. Sampling programs showed that the slurry penetrated the postglacial soil in horizontal and vertical patterns up to 5 ft from the injection holes. The method was only moderately successful in penetrating the glacial deposit. Plasticity index of the treated postglacial deposit soil was slightly reduced. Appreciable shear strength increases were noted in samples from both materials that did not contain lime seams. The method appears to be quite successful in soil stabilization, provided equipment and additives can be developed to aid penetration and migration of the slurry. (USBR)

W69-02930

obtained by using the rising head test instead of the falling head test. Test procedures and methods of data analysis are described. Sources of error in performing the test are discussed. In situ permeameters measure primarily horizontal permeabilities of foundation soils. Generally, they indicate a larger permeability than data from consolidation tests. Measured rates of settlement were in good agreement with the settlement rate determined from in situ permeabilities, indicating that either considerable horizontal drainage was occurring or in situ permeabilities were primarily affected by vertical permeability. Five projects are described where instrumentation was installed to illustrate reliability of the method. (USBR)

W69-02934

#### DENSIFICATION OF GRANULAR SOILS BY VIBRATIONS,

D'Appolonia (E.) Consulting Engineers, Inc., Pittsburgh, Pa.

E. D'Appolonia.

Michigan Univ Eng Summer Conf, June 1968. 91 p, 40 fig, 64 ref, append.

Descriptors: Density, \*Granular materials, \*Foundations, \*Sands, \*Soil density, \*Soil compaction, \*Soil dynamics, Soil stability, Settlement, Lifts (Construction), Compaction, Compacted soils, Stress-strain curves, Compaction tests, Relative density, Void ratio, Moisture content, Soil mechanics, Bibliographies.

Identifiers: Soil-structure interaction, \*Vibratory compaction.

Design and construction of sandfills to prevent settlement involve selecting the sand density required to prevent unsatisfactory performance of the fill and the compaction technique best suited to achieve the required density. The first problem involves developing methods for predicting the settlement of sand deposits under various vibratory loading conditions; the second problem involves establishing guidelines for selecting vibratory compaction equipment and compaction procedures. The first part of this presentation develops rational techniques for predicting settlement of foundations on granular soils subjected to vibratory loadings. Experimental research on the relationship between density and vibration parameters is reviewed. Methods for applying research findings to predict machine foundation settlements are discussed. The second part of the paper reviews results of recent field experiments with vibratory rollers. During these experiments, influence of roller size and operating frequency, lift height, and number of roller coverages on compacted density were investigated. Settlements of footings on compacted sand are compared with predicted settlements and are considerably smaller than expected. (USBR)

W69-02935

#### EQUILIBRIUM LIMITS OF EMBANKMENTS AND EARTH DAMS,

J. Biarez.

Trans from Ann Inst Tech Batiment Trav Publics, Vol 18, No 211-212, pp 1017-1030, July-Aug 1965. Bur Reclam Transl 644, Sept 1967. 33 p, 14 fig, 3 tab, 39 ref, append.

Descriptors: \*Equilibrium, Soils, Foundations, Soil moisture, Moments, Foundation investigations, Soil physical properties, \*Embankments, Soil stability, \*Earth dams, Stability analysis, Interstices, Safety factors, Friction, Cohesion, Soil pressure, Drawdown, Soil mechanics, Slip-circle methods, Slopes, \*Mohr circle, \*Slope stability, Bibliographies.

Identifiers: Coulomb law, \*Limit analysis.

The author examines one of the problems presented by embankments and earth dams—estimating the safety of a structure with respect to failure, taking into account the uncertainty of the data and the methods of calculation used. The problem consists of seeking, by 2 groups of calculation methods, the slip surface that gives the smal-

IN SITU PERMEABILITIES FOR DETERMINING RATES OF CONSOLIDATION,  
Weber (W. G.) and Associates, Inc., Sacramento, Calif.

William G. Weber, Jr.

Highw Res Rec, No 243, pp 49-61, 1968. 13 p, 10 fig, 4 tab, 7 ref.

Descriptors: \*Consolidation, Settlement, \*Permeability, \*Piezometers, Pore pressure, Pore water pressures, Sand drains, Hydrostatic pressure, Foundations, Field tests, \*Field permeability tests, Embankments, Soil mechanics, Instrumentation, \*Permeameters.

Identifiers: \*In situ tests, \*Permeability tests.

Variable-head permeameters measuring in situ permeabilities are used to predict the consolidation rate of foundation soil. The permeameters are non-metallic, porous, tube-type piezometers that serve a dual purpose of measuring excess hydrostatic pressures during construction. Better results are

lest safety factor. The first group of methods assumes plasticity in an extensive volume; the other group assumes that such volume is reduced to a thin area. For the second group, the author considers first the case of a homogeneous soil, and then that of a heterogeneous soil. The appendix covers a study of a dam on a foundation of very limited strength, and determination of the maximum surcharge on the edge of an embankment. (USBR) W69-02949

#### THE STRENGTH ALONG STRUCTURAL DISCONTINUITIES IN STIFF CLAYS,

Imperial Coll. of Science and Technology, London (England).

A. W. Skempton, and D. J. Petley.

Proc Geotech Conf Oslo 1967, Vol 2, pp 29-46, 1968. 18 p, 33 fig, 2 tab, 17 ref.

Descriptors: \*Clays, Clay shales, Soil stability, Bibliographies, Soil tests, Shear strength, Shear tests, \*Discontinuities, Joints, Slipping, Fractures, Mechanical properties, Deformation, Shear planes, Landslides, Cleavage, Internal friction, \*Soil mechanics, Joints (Geology).

Identifiers: \*Residual strength, \*Slip surface, Foreign testing, Great Britain, Slip planes.

Field and laboratory tests are described for measuring shear strength along principal slip surfaces, minor shears, and joint surfaces in clay strata. The clays were overconsolidated, with liquidity indices ranging from plus 0.1 to minus 0.4. Along principal slip surfaces (in landslides and tectonic shear zones), the strength is at or near the residual strength, typically 95% or more of peak strength. Test results show that this relation holds even where no renewal of movement has occurred during the past 10,000 yr. Minor shears, with irregular surfaces having small relative movements, show a strength appreciably above the residual strength. Joint surfaces display a brittle fracture texture with zero or exceedingly small movements along these surfaces. Tests available on London clay joint surfaces indicate that the fracture producing the joint virtually destroyed the cohesion intercept of the clay, but reduced the value of the effective angle of internal friction only 1.5 deg. Movements of less than 5 mm are sufficient to polish the surface and lower the strength along the joint to the residual strength. These discontinuities are all surfaces of weakness that reduce the strength of the clay mass far below the strength of the intact material. (USBR)

W69-02950

#### 8E. Rock Mechanics AND Geology

##### POSSIBILITIES AND LIMITATIONS OF GEOPHYSICAL METHODS APPLIED TO CIVIL ENGINEERING,

Electricite de France, Paris.

P. Duffaut.

Trans from Bull Tech Suisse Romande, No 9, pp 3-12, May 1967. Bur Reclam Transl 783, Oct 1968. 22 p, 9 fig, 11 ref.

Descriptors: \*Geophysics, Geophones, Subsurface investigations, Civil engineering, Foreign projects, Exploration, Geologic investigations, \*Engineering geology, \*Seismic investigations, Rocks, Alluvial deposits, \*Seismic properties, Seismic waves, Bedrock, Mechanical properties, Rock properties, Elasticity modulus, Structural geology, Damsites. Identifiers: Cavernous rock, Electrical logging, Electrical prospecting, France, Gravimetric prospecting, \*Geophysical prospecting.

The main objective of geophysical exploration is to determine the shape, size, and position of concealed geological structures. The striking contrast between the generally acknowledged effectiveness of geophysical methods in oil exploration and the variety of opinions encountered in the field of civil engineering is attributed to the occasional client

experiencing either a first failure or first success and the oil man's averaging of failures with a greater number of successes. For the geophysicist, there is no difference in principle between the study of an oil structure and the investigation of buried bedrock. The underlying reason for success or failure is found in the very nature of things, the geological content of the terrain. The report discusses the study of concealed structures, properties of subsurface materials, mechanical interpretation of geophysical parameters, and diagnosis of seismic velocity variations with time in rock masses. Examples of some French and other European experiences are given. (USBR) W69-02916

#### ROCK BREAKAGE BY CRUSHING, BLASTING, AND DRILLING,

Rice Univ., Houston, Tex.

J. B. Cheatham, Jr.

Eng Geol Int J, Vol 2, No 5, pp 293-314, Aug 1968. 22 p, 22 fig, 2 tab, 39 ref.

Descriptors: Rocks, \*Rock excavation, Rock mechanics, \*Cratering, Rock properties, Craters, \*Drilling, \*Crushing, \*Grinding, Fractures, Energy, \*Fragmentation, Energy dissipation, Bibliographies, Reviews, Rock crushers. Identifiers: Rock breakage, Brittle fracture theory.

Observations have provided empirical means for predicting energy requirements for rock fragmentation in crushing, blasting, and drilling, although the fundamental principles are not well understood. The state of knowledge of rock fracturing processes is surveyed and practical applications are discussed in rock comminution, cratering, and drilling. In most cases, an almost negligible amount of the total energy expended in rock breakage goes into useful work; most of the energy is dissipated as kinetic or thermal energy. Data analyses indicate that: (1) crushing uses several hundred times the energy actually required as surface energy, (2) blasting requires energy one order of magnitude greater than crushing, (3) and roller-bit drilling requires at least as much energy as blasting. In view of the limited energy directed toward actual rock fragmentation, rock breakage processes could be much more efficient. Empirical equations presently are used for equipment design and prediction of results. A better understanding of brittle fracture is needed to provide a more valid basis for comminution studies. (USBR)

W69-02920

#### HORIZONTAL BORING TECHNOLOGY: A STATE-OF-THE-ART-STUDY,

Bureau of Mines, Minneapolis, Minn.

For primary bibliographic entry see Field 08C. For abstract, see . W69-02923

#### A CONTRIBUTION TO THE DEVELOPMENT OF ROCK MECHANICS,

Belgrade Univ. (Yugoslavia).

Branislav Kujundzic.

Saopstenja, Vol 14, No 41-42, pp 83-102, 1967. 20 p, 30 fig, 27 ref.

Descriptors: \*Rock mechanics, Test procedures, Deformation, Grouting, Field investigations, \*Field tests, Rocks, Hydraulic jacks, Stress, Rock properties, Seismic investigations, Seismic properties, Stress analysis, \*Shear tests, Shear strength, Sliding, Tunnel pressures, Elasticity modulus. Identifiers: \*In situ tests, \*Jacking tests, Foreign testing, Rock pressures, Yugoslavia, Dilatometers, Borehole deformation gage.

Developments in rock mechanics at the Jaroslav Cerni Institute are reviewed. Test procedures developed include: (1) the hydraulic jack method, (2) the double jack method, (3) the radial press, (4) the borehole dilatometer, (5) a seismic method for determining the relationship between dynamic modulus of elasticity and static modulus of defor-

mation, (6) field shear tests, and (7) determination of stress underground. Each method is described. Rock is a heterogeneous, anisotropic, and discontinuous medium and must be investigated as a mass by large-scale in situ tests. Laboratory testing of small rock samples has little practical or theoretical value in rock mechanics. (USBR) W69-02947

#### SHEAR STRENGTH OF ROCK,

Coyne et Bellier, Bureau d'Ingenieurs Conseils, Paris (France).

Pierre Londe.

Proc Geotech Conf Oslo 1967, Vol 2, pp 91-99 and 223-259, 1968. 46 p, 105 fig, 37 ref, disc.

Descriptors: \*Rock mechanics, Rock foundations, Shear failures, Voids, \*Rocks, \*Shear strength, Shear tests, Reviews, Bibliographies, Stability analysis, \*Rupturing, Field tests, Laboratory tests, Brittle failures, Tensile strength, Rock properties, Foreign research, Joints (Geology). Identifiers: \*Rock slope stability, Brittle fracture theory, France, Finite element method, Griffith theory.

Important unsolved problems in the shear strength of rock are discussed by the General Reporter of the 1967 Oslo Conference. Analysis of all rock strength problems is divided into 2 parts: (1) determining possible large-scale failure patterns, with the help of theories based on observations; and (2) considering the strength of rock as measured by tests that attempt to reproduce actual rupture conditions. Theories on large-scale rupture are discussed with views on influence of rock mass structure, influence of time, evaluation of stresses, variations of voids, action of underground water, various phases of rock mass rupture, and theories of rupture. Strength tests are reviewed for the purposes of rock classification, similitude for establishing theories, and measurement of strength characteristics valid on the scale of the rock mass. Discussions by panel members cover topics on shear strength of rock masses, shear rupture patterns, shear failure in jointed rock, finite element analysis, and field and laboratory rock test procedures. (USBR)

W69-02951

#### 8F. Concrete

##### A SYSTEMS APPROACH TO ANALYSIS OF HARDENED CONCRETE,

Pennsylvania State Univ., University Park.

T. D. Larson, and P. D. Cady.

Mater Res Stand, Vol 8, No 10, pp 8-16, Oct 1968. 8 p, 12 fig, 5 tab, 9 ref.

Descriptors: Concretes, Concrete mixes, Concrete structures, \*Concrete technology, \*Concrete testing, \*Deterioration, Microscopy, \*Petrographic investigations, Analysis, Air void ratio, Water-cement ratio, Cracking, Sampling, Aggregates, Frost action. Identifiers: Cement paste, Concrete properties, Bridge decks, Freeze-thaw durability.

A procedure is described for examining hardened concrete specimens and evaluating concrete deterioration. The method combines microscopic linear traverse measurements of air void parameters, percent cement paste, and percent aggregate; determination of original water-traverse measurements are made on polished concrete specimens following ASTM Designation C 457-67T, and data processed on a digital electronic computer. The analysis of concrete core specimens, coupled with field observations, provides information for evaluating causes of concrete deterioration. The mode of deterioration often depends upon conditions and characteristics of the concrete in its early life, and since there are secondary and contributory effects, the fundamental causes may be difficult to identify after deterioration becomes obvious. The procedure for analyzing hardened concrete permits separation of basic and contributory mechanisms.

## Group 8F—Concrete

An example of analysis of concrete bridge deck deterioration is given. (USBR)  
W69-02909

## THE THEORY OF THE STRIP METHOD FOR DESIGN OF SLABS,

Building Research Station, Watford (England); and Warwick Univ., Coventry (England).

R. H. Wood, and G. S. T. Armer.

Proc Inst Civ Eng, Vol 41, pp 285-311, Oct 1968. 27 p, 25 fig, 7 tab, 14 ref, append.

Descriptors: \*Reinforced concrete, \*Slabs, Design, Design criteria, Design tools, Structural analysis, \*Structural design, Reinforcement, Limit design, Stress, Stress analysis, Moments.

Identifiers: Design analysis, Ultimate strength design, Yield line theory, Concentrated loading, Limit analysis, \*Strip method.

The strip method of Arne Hillerborg provides a powerful alternative to yield-line theory for ultimate-load design of reinforced-concrete slabs. The designer chooses the reinforcement layout as calculations progress, rather than by the trial and error method used in yield-line design. A critical examination of the strip method shows the original method to be remarkably simple to apply, but later developments are too complicated to be readily acceptable. The original method provides an exact (not a lower-bound) solution for the collapse load of a slab carrying distributed load if reinforcement were made to fit ideally. Point loads may be treated as local concentrations of distributed load. Although there is almost unlimited freedom of choice in placing reinforcement, the design chosen should be similar to that expected in elastic design. Shapes of discontinuities may be chosen favoring simple evaluation of reinforcement in distinct bands. Two rigorous and simplified alternatives are given to Hillerborg's advanced strip method which cause discontinuities in placing reinforcement. (USBR)

W69-02918

## ULTIMATE LOAD TESTS OF SLABS DESIGNED BY THE STRIP METHOD,

Building Research Station, Watford (England).

G. S. T. Armer.

Proc Inst Civ Eng, Vol 41, pp 313-331, Oct 1968. 19 p, 17 fig, 2 tab, 6 ref.

Descriptors: \*Reinforced concrete, \*Slabs, \*Model tests, Design, Limit design, Design tools, Structural analysis, \*Structural design, Cracking, Reinforcement, Deflection, Shear stress, Failures, Structural behavior, Stress, \*Ultimate loads.

Identifiers: Ultimate strength design, Yield line theory, \*Strip method, Limit analysis.

Tests were performed on half-scale model slabs designed by an ultimate load method known as the strip method. The method provides a safe design for ultimate load; slab behavior in terms of deflections and cracking at working loads is satisfactory. Models with punching shear failures showed considerable curtailment of the flatter section of the load-deflection curve. In some cases, ultimate load is grossly under-load-deflection curve. In some cases, ultimate load is grossly underestimated because flexural behavior is assumed to be all-important in determining such loads. There is little difference in the load-carrying efficiency of designs made using variations of the strip method. A compressive membrane effect was observed around the center support column. Resistance to punching is decreased by extensive cracking caused by yield lines, but may be aided by compressive membrane action. Punching shear is partially dependent on flexural strength; apparent flexural strength is dependent on the degree of compressive membrane action. Designs based on the strip method produce layouts of reinforcements very different from those based on the yield-line theory or Code of Practice. (USBR)

W69-02919

## MECHANISMS OF SHEAR RESISTANCE OF CONCRETE BEAMS,

Mott, Hay and Anderson, (Gt. Brit.); and Canterbury Univ., Christchurch, (New Zealand).

R. C. Fenwick, and Thomas Paulay.

Proc Amer Soc Civ Eng, J Struct Div, Vol 94, No ST10, pp 2325-2350, Oct 1968. 26 p, 14 fig, 10 ref, 2 append.

Descriptors: Reinforcement, \*Shear resistance, Shear, Shear cracks, Shear failures, \*Shear strength, \*Beams (Structural), Cantilevers, Shear tests, \*Reinforced concrete, Cracking, Shear stress, Dowels, Structural behavior, Flexural strength, Failure (Mechanics).

Identifiers: Shear distribution, \*Arch action, Bond strength, Diagonal tension, Compressive stress.

Study of the nature of shear resistance of reinforced concrete beams shows that shear may be resisted by beam and arch action. Essential structural elements of beam action are concrete blocks (formed between flexural cracks of the shear span) that behave as cantilevers restrained by the compression zone of the beam. Beam action breaks down at the diagonal cracking load of the shear span. Arch action cannot develop to an appreciable extent prior to diagonal cracking unless the beam contains prestressed reinforcement. About 60% of the strength of beam action results from the mechanism of shear transfer across the crack by interlocking of aggregate particles and about 20% results from dowel action of the reinforcement. Direct tests on aggregate interlocking action show that this shear transfer increases with concrete strength and reduction in crack width. Dowel capacity of bottom bars is considerably greater than that of top bars. Beam tests illustrate contradictions of these different mechanisms. (USBR)

W69-02927

## STRENGTH, DURABILITY, AND SHRINKAGE OF INCOMPLETELY COMPACTED CONCRETE,

Newcastle Univ., (Australia).

B. S. Heaton.

J Amer Concr Inst, No 10, Proc V 65, pp 846-850, Oct 1968. 5 p, 3 fig, 2 tab, 3 ref.

Descriptors: \*Concretes, \*Concrete mixes, \*Concrete placing, \*Concrete technology, \*Workability, Concrete structures, Concrete testing, Voids, Compressive strength, Water-cement ratio, Reinforced concrete, Slump, \*Compaction, Shrinkage, Durability.

Identifiers: Concrete slabs, Vibratory compaction, Australia, Foreign testing.

The effects of compactive effort of concrete on compressive strength, durability, and shrinkage were determined over a range of workabilities. Workable concrete obviously requires less effort for compaction, and compacted concrete is stronger than incompletely compacted concrete. The strength of low-workability concrete is reduced by voids from incomplete compaction. Increasing the workability of a given mix by adding water potentially weakens the concrete because of the increased water-cement ratio. The important question is whether the strength losses are greater from incomplete compaction of low-workability concrete or from high water-cement ratio of high-workability concrete. Tests of low-workability concrete at low levels of compactive effort show that increasing the water content may increase strength, produce a slight increase in shrinkage, possibly decrease durability, and improve the finish of formed surfaces. (USBR)

W69-02931

## CONSTRUCTING 500-KV TRANSMISSION LINES ON A SWAMPY RIVER FLOOD PLAIN,

N. I. Marfin.

Trans from Elek Sta, No 9, p 90, 1966. Bur Reclam Transl 553, Aug 1967. 4 p, 1 fig.

Descriptors: Transmission lines, \*Swamps, \*Transmission towers, Spans, Cold weather construction,

Foreign construction, Flood plains, Rivers, \*Crossings, Pile foundations, Ice, \*Footings, Precast concrete, \*Foundations. Identifiers: USSR, Grillage footings.

In the USSR, a 500-kv transmission line was constructed across the swampy flood plain of a river located in a severe climate area. The design length of the span was 410 m. Intermediate towers were erected on islands of imported soil, built up above flood level, and sown with grass to prevent wind erosion. The 1:2 slopes of the islands, sodded to prevent water or ice damage, continue beyond swamp level as clay-cement cutoffs. The heavy construction work was done in the winter since the swamp was impassable to heavy equipment at any other time. A foundation of precast footings was constructed on reinforced concrete piles, vibro-driven deep into the subsoil. The piles were interconnected just below swamp level by a monolithic, frost-resistant, reinforced concrete grillage foundation. The reinforcing mesh of the grillage was welded to the longitudinal reinforcement of the piles before concreting. This type of foundation is recommended for 330- to 750-kv transmission lines crossing swampy areas. (USBR)

W69-02936

## ANCHORED FOOTINGS FOR TRANSMISSION TOWERS,

Bureau of Reclamation, Denver, Colo.

Richard S. Saliman, and Robert H. Schaefer.

Preprint 753, Amer Soc Civ Eng Annual Meet Nat Meet Struct Eng, Pittsburgh, Pa, Sept/Oct 1968. 28 p, 14 fig.

Descriptors: \*Transmission towers, Anchors, Bars, Failure (Mechanics), Reinforcing steel, \*Footings, Rock foundations, Grouting, Soil physical properties, Experimental data, Field tests, Drill holes, Safety factors, Deflection, Foundation investigations, \*Anchored towers, Foundations.

Identifiers: \*Anchored footings, Uplift footings, In situ tests, \*Rock footings, \*Pull-out tests, Bellied anchors, Auger-type footings.

Anchor bar footings consist of a formed reinforced concrete cap into which the leg or stub angle extension of the leg of a transmission line tower is embedded and which is anchored into rock or soil by grouting reinforcing bars into drilled holes. This paper reviews pullout tests conducted by the Bureau of Reclamation on anchor bars grouted into rock or soil. Results of these tests have been used as a basis for designing transmission line footings. Development of rock-type footings designed for use in sound rock and adaptation of these footings for use in various soils are presented. Field tests on full-scale anchor bar footings are discussed. Additional footing tests are planned. (USBR)

CONCRETE RESERVOIR DESIGN,  
Montgomery (James M.) Construction Engineers, Inc., Pasadena, Calif.  
For primary bibliographic entry see Field 08A.  
For abstract, see .  
W69-02952

## 8G. Materials

RAWCLIFFE BRIDGE IN YORKSHIRE,  
West Riding County Council, Yorkshire (England).

F. A. Sims, and S. Woodhead.

Civ Eng Pub Works Rev, Vol 63, No 741, pp 385-391, Apr 1968. 5 p, 10 fig.

Descriptors: \*Concrete technology, \*Epoxy resins, Beams (Structural), Bridge design, Bridge construction, Test procedures, \*Highway bridges, Shear tests, Joints (Connections), Stress, Reinforced concrete, Precast concrete, Prestressed concrete, Strain gages, \*Bridges.  
Identifiers: Great Britain, \*Rawcliffe Bridge (Great Britain), Test results, Compression tests, Bend tests.

Epoxy resin joints in segmental-beam construction for bridges were first used in England on the Rawcliffe Bridge in Yorkshire. Difficult approach alignments, the existence of residential property adjacent to the approaches, and the River Board's stringent limitations on use of temporary staging in the fast-flowing tidal river dictated using balanced-cantilever and suspended-span construction when rebuilding this bridge. The contractor proposed segmental construction of the 4 main beam units that were precast on site in 5 segments, each weighing 10 to 12 tons and cast one against the other to give matching interfaces. These sections were transferred from the casting beds to temporary staging between the main supporting columns and the river bank, launched to an intermediate position, and jointed with an epoxy resin adhesive. Steel cleats with bolted connections anchored to the base of the segments were used to apply pressure to the epoxy joints by clamping the units together. Results of preliminary tests and the appearance of finished beams that have been in position for over 9 mo are discussed. Specially treated vertical joints are not visible after weathering and beams appear to have been cast as complete monolithic units. (USBR)  
W69-02926

#### INCrustation IN WATER PIPELINES,

Bureau of Reclamation, Boulder City, Nev.

Monroe O. Moore.

Proc Amer Soc Civ Eng, J Pipeline Div, Vol 94, No PL1, pp 37-47, Oct 1968. 11 p. 8 fig, 3 tab, append.

Descriptors: \*Water pipes, Water supply systems, Pipelines, \*Pipes, \*Protective coatings, \*Steel pipes, \*Coal tar coating, Enamels, \*Iron bacteria, Microorganisms, Costs, Pump testing, Municipal water, \*Fouling, Linings, Operation and maintenance, Maintenance.

Identifiers: \*Pipe linings, \*Incrustation, Pumping tests, Microbes, \*Cast iron pipe, Corrosion environments.

The water supply system at Boulder City, Nev., was inspected and tested with respect to problems caused by bacterial incrustation in portions of the system's pipelines. Observations of pipeline incrustations and pumping test results are discussed. Laboratory analysis identified the incrustation as an iron bacteria, *Gallionella ferruginea*, which feeds on iron and manganese in solution. Uncontrolled incrustations build up and reduce carrying capacity, increase pumping and maintenance costs, and provide conditions conducive to corrosion-producing bacteria. Cleaning or pipeline replacement will be required eventually. Those portions of the pipeline lined with coal-tar enamel are in good condition because the bacteria have difficulty becoming attached to the smooth lining. Coal-tar enamel also resists microbial attack. Analysis of electrical energy costs for pumping indicate that savings in 1 year would exceed the cost of treating the pipe with coal-tar enamel. (USBR)  
W69-02928

#### PROSPECTS FOR USE OF NONMETALLIC REINFORCEMENT,

E. N. Smirnov.

Trans from *Avtomat Dorogi*, Vol 26, No 12, pp 18-23, 1963. Bur Reclam Transl 575, 1967. 8 p, 1 tab, 4 ref.

Descriptors: \*Plastics, Precast concrete, Tensile strength, Stressing cables, \*Prestressed concrete, \*Reinforced concrete, Reinforcing steel, \*Reinforcing, Compressive strength, Pavements, \*Glass fibers, Elasticity (Mechanical), Elasticity modulus, \*Synthetic fibers, Deformation, Slabs, Elastic deformation, Foreign research, Relaxation, Stress. Identifiers: \*Reinforcing materials, USSR.

Soviet researchers are advocating further development of glass-fiber reinforcement for precast, prestressed paving slabs and bridge elements. Analysis of available domestic plastic-reinforcing materials and binders showed 2 types developed by the Belorussian Academy of Sciences to have the greatest strength and best bond with concrete. One type was 7-micron-dia glass fibers made in coils from noncaustic aluminoborosilicate and epoxy resin; the other was a noncaustic nonboric fiberglass composition with epoxyphenol resin. The strength of the latter is near that of high-strength steels and its bond resistance in concrete reaches 70 kg/sq cm, exceeding that of equal-diameter deformed steel strands. Available forms are smooth and deformed rods, ribbons, and prefabricated shapes made by twisting glass fibers and coating them with resins and polymers. Because of lighter unit weight, resistance to corrosion, and lower stress losses to shrinkage and creep of concrete (5 to 6 times less than high-strength steel), using plastic reinforcing is recommended for many structures. However, present cost is high because of lack of industrial manufacturing methods and high price of raw materials. The lower toughness of plastic reinforcement relative to steel introduces problems in selecting tensioning devices. (USBR)  
W69-02937

#### RECENT DEVELOPMENTS IN PLASTIC DESIGN PRACTICE,

Lehigh Univ., Bethlehem, Pa.

Lynn S. Beedle, Le-Wu Lu, and Lee Chong Lim. Preprint 752, Amer Soc Civ Eng Annual Meet Nat Meet Struct Eng, Pittsburgh, Pa, Sept/Oct 1968. 41 p, 1 fig, 6 tab, 80 ref, append.

Descriptors: \*Structural design, Structural steel, Plasticity, Load factors, \*Continuous frames, Structural engineering, Loads (Forces), Design criteria, Frames, Bracings, Optimum design, Buildings, Research and development, \*Plastic theory, \*Continuous beams, Buckling, Steel structures, Structural analysis, Bibliographies. Identifiers: \*Plastic design, \*Design practices, High strength alloys, \*Multistory buildings.

Considerable new information has become available in the last decade concerning research results on inelastic behavior of steel structures and experience gained from design applications. This information is being used for plastic design, allowable-stress design, and seismic design. Increased interest is being shown in the significance and magnitude of load factors and in the possible use of multiple-load factors in design. The Second Edition of the Plastic Design Commentary will reflect the latest knowledge. Specifications are reflecting these changes also—for example, the American

Railway Engineering Association and the American Institute of Steel Construction specifications. Areas of additional study to make possible further improvements in the design of steel structures, are identified. Topics such as local and lateral buckling, inelastic rotation requirements, composite and box members, space frameworks, and evaluation of structural safety can profit from additional examination. These studies will make possible a more complete use of the strength of steel in the plastic range. (USBR)  
W69-02942

#### COMPARISON OF THREE COMMERCIAL DRAIN TILES IN A HEAVY CLAY SOIL OF IMPERIAL VALLEY,

California Univ., Davis. Dept. of Water Science and Engineering.

F. E. Robinson, and J. N. Luthin. Calif Agr, Vol 22, No 8, pp 10-11, Aug 1968. 2 p, 2 fig, 4 tab.

Descriptors: Tiles, Tile drains, Water loss, Salinity, Leaching, Ponds, Soil types, Drainage systems, Clays, Evaporation, Flooding, Flow rates, Effluents, Electrical conductance, Hydraulic conductivity, On-site tests, Seepage, Saturation. Identifiers: Imperial Valley (California).

In January 1964, pairs of clay, concrete, and bituminous-fibre tiles were installed in a 40-acre field at the Imperial Valley Field Station. Initial tests of these three materials were conducted in 1966 and are reported in this paper. No evidence was found in these tests of real differences in performance between clay, concrete or bituminous-fibre tiles. Soil variation and not tile performance was responsible for differences in tile outflow. Little actual change in salinity resulted from the leaching operation in the body of soil between the tiles. In most cases as much, and often more, water was lost through seepage as was removed by the tile. (A-fleck-Arizona)  
W69-02977

#### 09. MANPOWER, GRANTS AND FACILITIES

#### 9C. Research Facilities

##### WATER POLLUTION RESEARCH 1967.

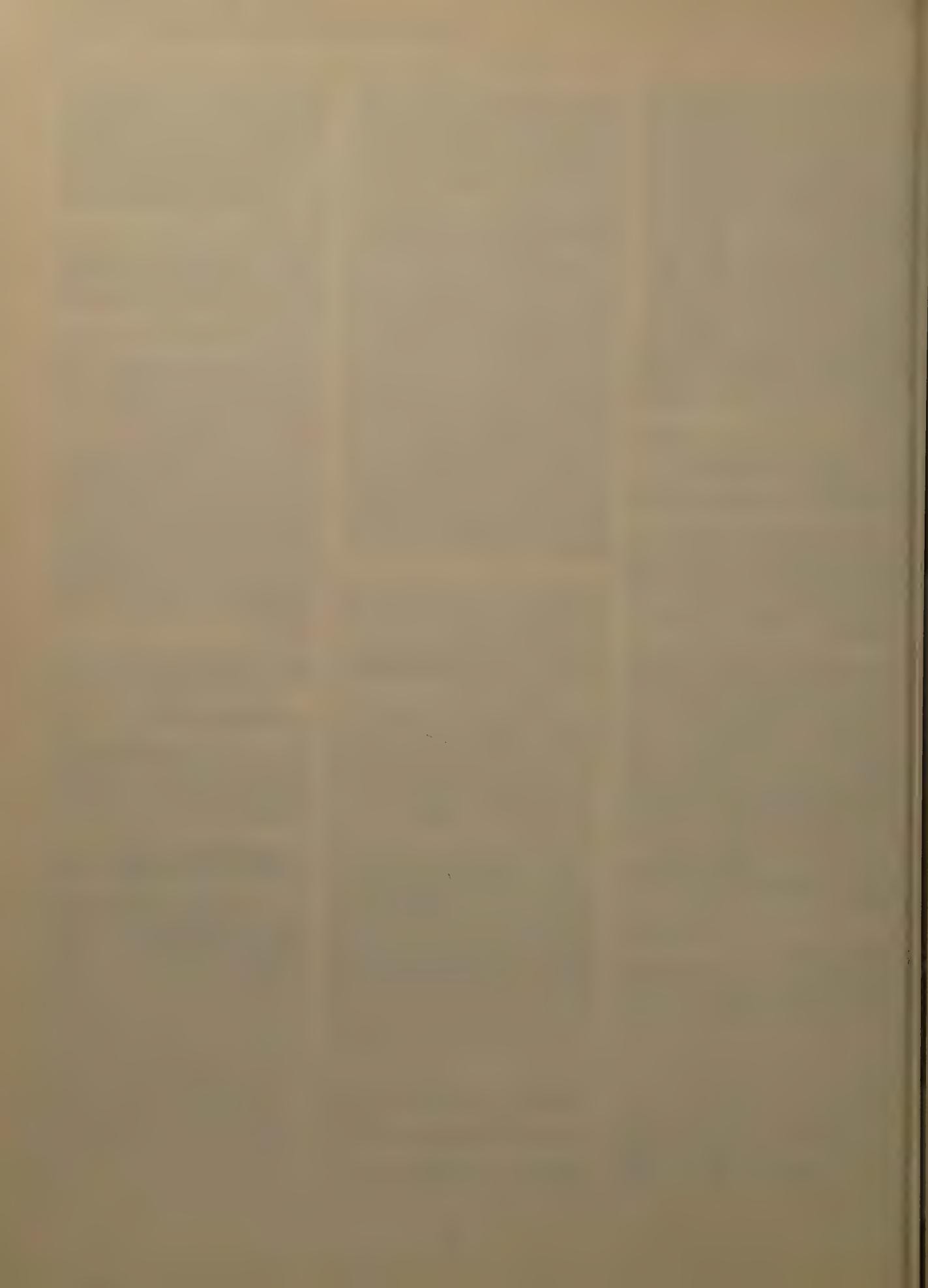
Water Pollution Research Steering Committee, London (England).

For primary bibliographic entry see Field 05G.  
For abstract, see .  
W69-03065

#### 10. SCIENTIFIC AND TECHNICAL INFORMATION

##### THE INFORMATION BACKGROUND IN THE FIELD OF BIOLOGICAL DETERIORATION OF NONMETALLIC MATERIALS,

Thompson (John I.) and Co, Washington, D. C. For primary bibliographic entry see Field 08C.  
For abstract, see .  
W69-02905



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